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TREATISE

—ON—

EMBALMING

INCLUDING

A FULL AND CONCISE DESCRIPTION OF THE METHODS TO BE EMPLOYED FOR THE PRESERVATION OF THE HUMAN BODY AFTER DEATH, BY CHEMICAL OR OTHER KNOWN PROCESSES;

TOGETHER WITH A FULL DESCRIPTION OF CHEMICALS EMPLOYED IN EUROPE AND THE UNITED STATES, BY THE MOST EMINENT CHEMISTS AND PROFESSORS; ALSO, SUCH ANATOMICAL, PHYSIOLOGICAL AND CHEMICAL FACTS, AS ARE NECESSARY TO BE UNDERSTOOD, IN ORDER THAT SCIENTIFIC MANIPULATIONS MAY BE FULLY CARRIED OUT.

BY

M. LESSLEY.

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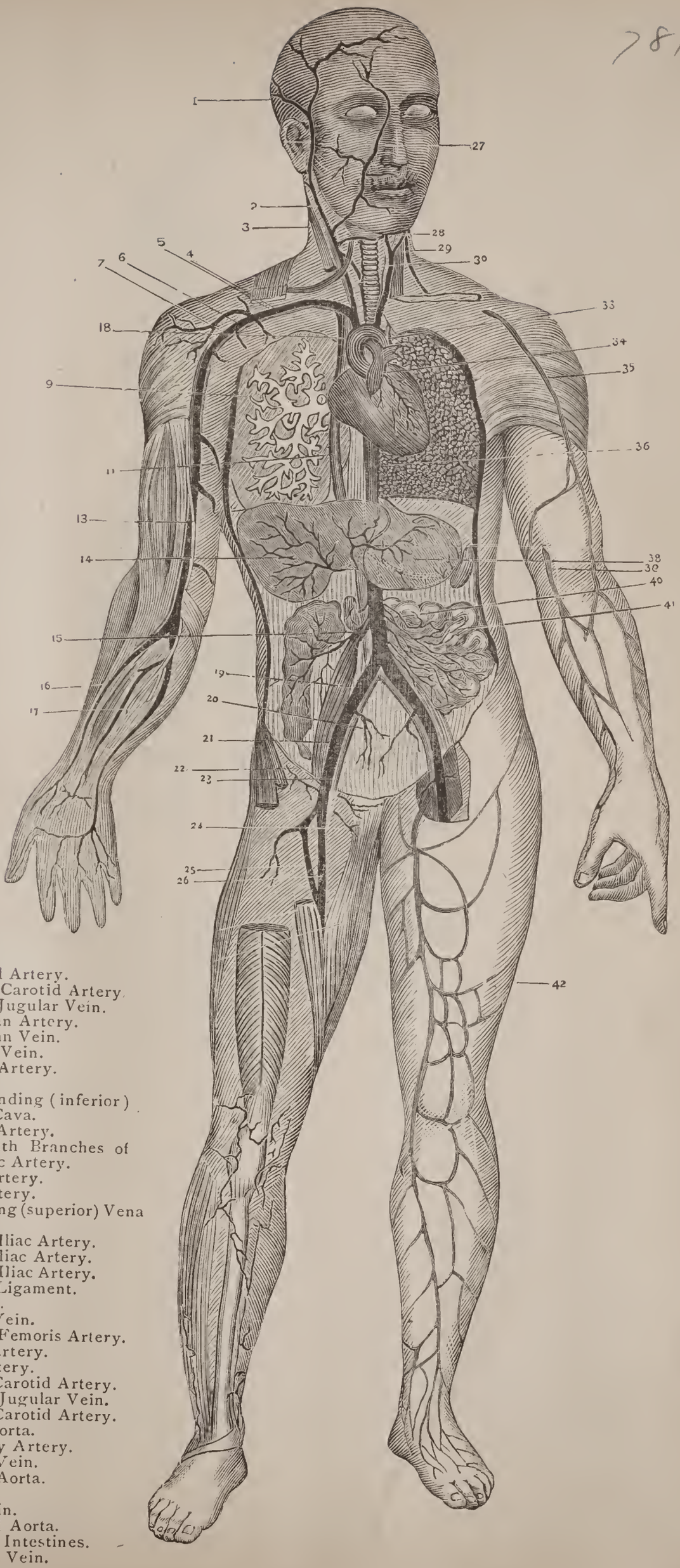

1. Temporal Artery.
2. External Carotid Artery.
3. Internal Jugular Vein.
4. Subclavian Artery.
5. Subclavian Vein.
6. Axillary Vein.
7. Axillary Artery.
9. Lung.
11 & 15. Ascending (inferior) Vena Cava.
13. Brachial Artery.
14. Liver, with Branches of Hepatic Artery.
16. Radial Artery.
17. Ulnar Artery.
18. Descending (superior) Vena Cava.
19. Common Iliac Artery.
20. Internal Iliac Artery.
21. External Iliac Artery.
22. Pouparts Ligament.
23. Iliac Vein.
24. Femoral Vein.
25. Profunda Femoris Artery.
26. Femoral Artery.
27. Facial Artery.
28. Internal Carotid Artery.
29. External Jugular Vein.
30. Common Carotid Artery.
33. Arch of Aorta.
34. Pulmonary Artery.
35. Cephalic Vein.
36. Thoracic Aorta.
38. Stomach.
39. Basilic Vein.
40. Abdominal Aorta.
41. Section of Intestines.
42. Saphenous Vein.

DR. ROBERT KOCH,

LEARNED SPECIALIST IN CHOLERA AND PRESIDENT OF THE INTERNATIONAL CHOLERA COMMISSION.

News of the outbreak of cholera at Toulon, France, in June of this year, created alarm throughout the civilized world. Unfortunately the sanitary condition of the city was so bad as to assist the spread of the disease, to which many persons have already fallen victims. At an early period of the outbreak, Dr. Koch, who had been engaged to report on it, expressed the opinion that the pestilence could not be confined to France, but that it would spread into other countries. This statement by an authority of the first eminence, intensified popular excitement, as it may now seem at first glance unnecessarily, for there are indications that probably the cholera has done its worst in Europe this summer; but the zeal to adopt every practicable means to prevent the spread of the disease, which his words provoked, may be the chief reason why the outlook is more favorable than appeared possible only a short time ago.

Dr. Robert Koch is a German who has made cholera the special subject of his study. His researches as to its nature and origin have been made in India and Egypt, with the results which give him unrivalled distinction in the branch of investigation which he has followed. Moreover, the German Government has rewarded him munificently for his labors, in the shape of a large sum of money. France, in her alarm, casting away national prejudice, called upon the learned German to advise what should be done to save her people from the deadly plague of cholera.

MONS. PASTEUR, THE EMINENT CHEMIST OF FRANCE.

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INTRODUCTION.

IN PRESENTING this book to the profession, the author thought it advisable to give to the embalmers and medical students all the practical advice, sound sense and all information which was possible to be obtained, on physiology, animal chemistry, anatomy, etc. This is principally from the writings and publications of Messrs. Augustus Renouard and W. W. Ball, both eminent chemists in the United States.

The more closely these pages are studied, the more satisfactory will be the knowledge gleaned by the student; and if any individual supposes he can master the details without laborious application, he may as well stop before beginning, for he will spend his time and strength in vain. The study of the facts herein contained, will be for the student not only interesting but really fascinating. The author has also given herein the processes of chemical embalming and the preservation of dead human bodies, with the different ingredients of fluids used, not only in this country, but also in Great Britain, France, Italy and Germany, from the experience of facts obtained by the most eminent professional chemists and embalmers; also, all the results from experiments made, how they acted upon the different systems, etc.

We must take up the study of embalming if we would build it up, for with study and observation only, can the student hope to be successful; for it is true that much is yet to be accomplished, and if we would hope to overcome difficulties, we must bring every feature of this into the more desirable shape of an exact science. The object is to instruct, as well as to create interest in the profession, by developing scientific facts which are necessary to promote the avocation of a funeral director to the rank which it deservedly ought to occupy. Some of the chapters which may seem superfluous are all essential to a clear understanding of the different processes of embalming and preserving

dead bodies; had these been left out, it would have been a puzzle to many. It was also found necessary to elucidate the *modus operandi* of each process by giving reasons for the use of the chemicals, their mode of action and the results to be expected by a careful use of them. The quantities of the chemicals to be used must be left entirely to the good judgment of the operator; this can only be obtained by good practice and close watching, but to satisfy the investigating propensities of all, the nature or properties of the different chemicals used have been explained at length.

The chapter devoted to anatomy, the arterial circulation and the different parts of the human structure, will be found indispensible and when properly understood will greatly facilitate the work of the operator. If the embalmer be ignorant of the locations of the different organs, the courses of the veins and arteries, their relations and positions, how can he find the point of injection and go on successfully with his work? It is necessary for him to have this knowledge to accomplish his task so that he may know with any degree of certainty when the process of injecting is complete, and that the parts intended have been reached by the fluid.

Allied to the above are the conditions of the body after death, as governed by circumstances which may affect and thereby modify the treatment thereof, as different modes of treatment are required in different cases. How can the operator discriminate, if he is not warned beforehand, in case his knowledge does not teach him what course to follow, and this knowledge can only be obtained by making it a point to study at least that part of the human organism with which he may have to deal.

As the different processes given herein for embalming and preserving human bodies are founded upon practical experiments, it becomes then necessary that the principles be fully explained. What has been said about anatomy applies also as well to the study of animal chemistry. The constituents of the human body, fluid and solid, have all more or less different properties, their composition varies also to a great extent. Therefore it is a point of material importance to know and understand their formation, the causes which may lead to their decay or putrefaction, and also the means which may be employed to the best advantage to counteract their tendency to disintegration.

It may also be useful to repeat here certain injunctions as to the dangers to be encountered in the handling of the dead and also of the proper care to be exercised in avoiding to rush heedlessly into danger and aggravate the perils of themselves. The embalmer, and the perils attending in many instances the discharge of his duties as a general thing, are very seldom thought of by those outside of the profession. To a great many this business has something dreadful about it. This impression is altogether an erroneous one, which ought to be eradicated from public sentiment. Embalmers, as a class, are men useful to society, their calling, far from being horrible, as the ignorant and shallow minded are pleased to call it, is one which requires a great deal of self denial, and which often brings to the surface the finest traits of human nature. It is incumbent upon professionals to protect themselves against contagion by all means that knowledge, experience and science may suggest. One great mistake, and one which has been repeated too often is, the false security some may place in the use of strong liquors to combat and render void the effects of contagion. This has been a stumbling block to many. We here safely assert that a great many of our professionals have fallen victims to the effects of alcohol, which, being used at first as a sort of medical preventative, soon assumes full control over the mind, and baffles their best efforts to resist it. If we are to look anywhere for a preventative of contagion and infection, we must look to the directions and remedies which medical science holds in store; and also the undisputable fact, that in the caution used and the care exercised in handling bodies, assisted by a discriminating judgment, lies our best pledges of safety. All the known modes of embalming and preserving bodies, known to be good and reliable, and found to have given entire satisfaction, have been given; there are other methods which may be good, but until they are found by actual and practical experiments to be worthy the merits claimed for them, they cannot be made public at present.

The author also expresses his many thanks for the kindness of Dr. W. C. Chapman, Professor of Materia Medica and Therapeutics, in Northwestern Ohio Medical College of this city, in making valuable suggestions during the preparation of the work.

THE ARTERIAL SYSTEM.

To understand thoroughly the process of embalming, it will be necessary to give here a brief explanation of the circulatory system; also to explain the position of the different parts of the viscera.

The arteries commence from the great arterial trunk, called the aorta, and their branches are distributed to all parts of the system; they are dense in structure, and preserve for the most part their cylindrical form when emptied of their blood, which is their condition after death.

The aorta arises from the left ventricle, at the middle of the root of the heart; it ascends at first forwards and to the right, then curves backwards and to the left, and descends on the left side of the vertebral column to the fourth lumbar vertebra; here it is divided into the arch and descending aorta.

It should be here remembered that most of the branches, which spring from the great artery and vein are double, that is, each right branch has a corresponding one on the left side—so that there are for instance, the right and left carotid arteries, the right and left jugular veins, etc. From the arch of the aorta are sent off those arteries which are distributed to the head and arms; the principal ones among these are named as follows: The *carotid* artery, which ascends in the side of the neck and divides into the *temporal* artery, which is distributed in the temple, and the *facial* artery which supplies the face, and also sends a branch called the *internal carotid* to the parts within the skull. The *sub-clavian* artery lying beneath the clavicle or collar bone—that part of the continuation of their artery which passes through the axilla or arm pit, is called the *axilliary* artery; its continuation in the upper part of the arm, the *brachial* artery; and in the fore-arm it divides into the *radial* and *ulnar* arteries, which are distributed to the hands and fingers.

The principal branches of the descending aorta are as follows: The *iliac* artery, which on passing into the thigh becomes the *femoral* artery, and in the leg divides into the *tibial* and *peroneal* arteries, which form numerous branches for the supply of the leg and foot.

Before dividing into the iliac arteries the descending aorta gives off several important branches, as the *coeliac* artery, from which the stomach and liver are supplied; the *renal* artery, which goes to the kidneys, and the *mesenteric* artery to the intestines; besides many other sub-divisions in various parts of its course.

The Veins.—The veins are the vessels which return the blood to the heart, after it has been circulated by the arteries through the different tissues of the body; they are much thinner in structure than the arteries, so that when emptied of their blood, they become flattened and collapsed.

The veins of the trunk may be divided into the superior vena cava with its formative branches, and the inferior vena cava with its branches also.

The superior vena cava is formed by the junction of the right and left vena innominata; it is a short trunk about three inches in length; it descends perpendicularly on the right side of the arch of the aorta, and terminates in the upper part of the right auricle of the heart. The right vena innominata receives the veins of the neck, which return the blood from the head as follows: The internal, external and anterior jugular veins. The external jugular vein being the one which is ordinarily open to let out the extravasated blood from the head—it will not be a miss to describe its course. It descends the neck in the direction of a line drawn from the angle of the lower jaw to the middle of the collar bone, and terminates into the sub-clavian vein; it is variable in size, and replaced by two veins. The sub-clavian vein becomes the axillary vein near the arm pit, and opens into the brachial veins down to the bend of the elbow, where it is divided into several branches which supply the fore-arm and the hand.

The inferior vena cava is formed by the union of the two common iliac veins; it ascends along the front of the vertebral column or back bone, and passing through the fissure in the posterior border of the liver, terminates in the inferior part of the

right auricle of the heart. Its branches are the lumbar veins, three or four in number, which collect the blood from the muscles and integuments of the loins and spinal veins; the renal veins, which return the blood from the kidneys, and the hepatic vein in the liver.

The common iliac veins, which, by their union form the inferior vena cava, are in turn formed by the union of the internal and external iliac veins; the external iliac vein passing into the thigh becomes the femoral vein, and is found in the same sheath with the femoral artery; further below it becomes the popliteal vein; about one inch and a half below Popart's ligament or groin in the upper part of the thigh, the femoral vein receives the internal saphenous vein, which commences at the inner side of the foot and great toe; it ascends in front of the inner ankle and along the inner side of the leg; it then passes behind and along the inner side of the thigh to the saphenous opening, where it pierces the sheath of the femoral vessels and terminates as above stated, in the femoral vein.

The above explanation of the circulatory blood vessels is given for the—right side. The branch vessels, the aorta and the vena cava on the left side are the same, with very slight modifications.

DIGESTIVE ORGANS.

The *œsophagus* is a slightly flexuous canal, inclining to the left in the neck, and to the right in the upper part of the thorax; it commences at the termination of the *pharynx*, which is a musculo-membranous sac, about four inches in length, and communicating with the cavity of the nose and mouth; the œsophagus then passes behind the arch of the aorta to the œsophagal opening in the diaphragam, where it enters the abdomen and terminates into the stomach.

The *stomach* in man is an oblong, membranous bag, placed obliquely across the abdomen and just below the diaphragm; its average capacity in the adult is about one quart; it has two openings, one towards the heart called the *cardiac orifice*, which receives the food from the œsophagus, and the other at the right

or small end of the stomach, called the *pyloric orifice*, for the transmission of food to the small intestines.

The *small intestines*, about twenty five feet in length, are coiled in various directions and terminate into the *large intestine*, called the *colon*, which is about five feet in length and resembles in appearance a long sac divided into numerous pouches.

The *pancreas* is a long narrow gland, situated partly behind the right side of the stomach, and within the first curve of the small intestines.

The *liver* is the largest gland in the body; it is situated on the right side, below, and in contact with the diaphragam, and is divided into several lobes. At its lower side is the *gall bladder*, into which the bile is poured after being secreted. Its duct opens into the duct leading direct from the liver, and forms with it the common bile duct, through which the bile is poured into the small intestine, at the same point with the duct from the pancreas, until at length, it is carried with the food into the larger intestine or colon, from whence it is excreted from the system through the rectum.

ORGANS OF RESPIRATION.

The lungs are supplied with air, through the larynx and trachea. The *larynx* is an irregular cartilaginous tube, forming the upper part of the wind-pipe, as the wholy tube is generally called. The *larynx* is situated immediately below the root of the tongue, and forms the protuberance in the front part of the neck, called Adam's apple.

The *trachea*, which is a continuation of the larynx, is composed of about eighteen cartilaginous rings, connected together so as to form a tube, which is capable of maintaining a uniform size. On entering the chest, the trachea divides into two trunks, called *bronchi*, one of which goes to the right and the other to the left lung. As soon as the bronchi enter the lungs, they branch off into numerous divisions and sub-divisions; their ultimate extremities terminate in air cells.

The lungs occupy the greater part of the chest, the heart being the organ of much volume which it includes in it.

The *chest* or *thorax* is a cavity closed on all sides from the entrance of air, and its bony walls afford an admirable protection to the delicate organs included within it. The walls of the thorax are formed by the breast-bone in front, by the ribs and spine on the side and back, and by the *diaphragm* below.

The *diaphragm* is a large muscular partition which separates the chest from the abdomen.

The explanations given herein, as also the arterial and venous circulation, upon the names, places, and relations of the abdominal and thoracic visera, will be found of the utmost importance to understand fully the process of embalming.

Although briefly enunciated, this review of the anatomy of the parts of the human body which the embalmer must be conversant with, will be found quite sufficient for the purpose. It was necessary that the names of the different organs mentioned in this work should be explained, so as to make the use of the technical words comprehensive to every undertaker, who is not now supposed to be familiar with the terms of the dissecting room of the human organism in general.

ANALYSIS OF THE HUMAN BODY.

FLESH.—If we take a portion of the flesh of a man and examine it by chemical analysis, we find it consists principally of four elements, which are found commonly in the things which surround us in this world. These four elements are called the organic elements, because they are universally found present in plants and animals, which are called organic beings, on account of which they carry on their life. The names given to these four elements are *Carbon*, *Hydrogen*, *Oxygen* and *Nitrogen*.

Carbon is the only one of the four elements that is solid at the ordinary temperature of the atmosphere. In its impure form, we know it by name of charcoal or coal, but in one of its pure forms it constitutes the diamond. When carbon combines with oxygen it forms a gas called carbonic acid. It is said that a human body weighing *154 pounds*, contains *21 pounds* of carbon.

Hydrogen.—That element is a gas. It is the lightest body known in nature. Hydrogen unites with carbon and forms the

gas which is burned to light our streets and houses. When hydrogen burns in the oxygen of the air, vapor of water is formed; *thus water is oxygen and hydrogen.* In the human body weighing 154 pounds there are *14 pounds* of hydrogen.

Oxygen is a gas, and one of the most active elements. In nature it unites with other elements and causes them to burn by flame or the process of slow combustion (oxydization.) It enters largely into all compounds of the human system, and a body weighing 154 pounds, contains *111 pounds of oxygen.*

Nitrogen is also a gas. It is by itself far less active as a chemical agent than the other three. A body weighing 154 pounds contains only about *3 1-2 pounds* of nitrogen; but it is just as important to life, as it combines with the other elements to give chemical action.

There are also about *4 pounds* of other elements. These consist principally of metals, calcium, sodium, potassium and iron. In the human body of the above weight there are *1 pound* and *12 ounces* of *phosphorus* and *2 pounds* of *calcium.* This last is a metal of which the earth lime is an oxide.

The elements above mentioned are not found pure in the human body, but are united together, forming a number of compounds, out of which the various organs are formed. The principals are water, gelatine, albumen and fat.

Now it will be observed that a body weighing 154 pounds, contains *111 pounds of water, 15 pounds of gelatine, 4 1 4 of albumen,* nearly *the same of fibrine,* and *12 pounds of fat. Water is the most important constituent of the human body,* since it goes to make up every portion of it. It is found within the solid flesh tissues, as well as in the blood, and is also present in the fats, as well as in all the juices or fluids of the entire system.

There is a larger portion of this fluid in fleshy persons than in the lean, and of course more of this destructive element in the bodies of children than in the old. Nature gives the first the plastic fluids for their more rapid growth, with life, health and vigor, which in the latter has been exhausted, and in a similar manner we may note disease over health, especially that class of disease which tend to remove or exhaust the fluid of the body by their destructive tendency. This we find in long stages of fever or comsumption, while the opposite is found in death by accident, apoplexy or dropsy. With the first the flesh is seemingly

dried to a parchment, while in the latter are found all the fluids, which if evaporated would prove to be mostly oil and water.

The Blood.—The *blood* of the *human system* amounts to about *18 pounds* or nearly *10 quarts.* It has a specific gravity a little greater than that of *water;* is of a *bright scarlet* color if drawn from an *artery*, or *dark purple* if taken from a *vein*, with a taste slightly alkaline, and an odor resembling that of the breath of the animal from which it is taken. It penetrates every solid tissue of the system, as may be known by puncturing any part of the body with even a pin, when blood is sure to follow. If it be examined with a microscope when freshly drawn, it appears to be made up of a *transparent liquid* called the *serum* or *plasma*, and a number of minute circular bodies, mostly of a red color, called corpucles or minute bodies. This fluid is found on analysis to be made up of *albumen*, *fibrine* and *several salts*, some of which are found in distinct crystals, and after it has been drawn from the body a considerable time, it *separates* into a *thickened* mass called coagulum, made up of fibrine and the corpuscles, while the *serum* with the *albumen still remain as a transparent liquid.*

The red corpucles prove to be the flattened discs with both surfaces slightly concave, and measuring about 1.2300 of an inch in diameter, and are in reality nothing but a cell that is a bag or sack containing a fluid composed of the two proximate principles,—globuline and hematine. Besides the red corpucles, there exists another kind of blood known as the white or colorless corpucles. They are by no means so abundant when the body is in health as the red corpucle. But in some diseases, and especially after death, the blood changes into a black or inky condition, which is termed ecchymosed. This fluid is that which presents itself at the surface to blacken the face, as soon as the gases generate sufficiently to fill the cavities, and depress the large vessels.

The Lymphatic System and Fatty Substances of the Body. —The lymphatics are those fluids mostly encountered in the fleshy and the young, and those who die suddenly by disease or accident. They become most difficult classes of bodies for the embalmer to handle, as these fluid conditions are those which but few of our profession can successfully master. A preserving

fluid must reach all of the small arteries of the entire system so that the flesh and fatty substances may absorb it, as Prof. W. W. Ball says in his Elementary Treatise on Embalming: I have injected three pails of water in the body of a man, but the water is not a perservative; in fact it is the water of the flesh that we must dispose of, but as we cannot fully accomplish this we must do what we can to *dry* it or *evaporate* it from the body by chemical reaction. It is useless to inject fluid that will destroy the tissues, or use a fluid that may clog the arteries, and accomplish nothing, and here, when proper relief is given to all the distanted cavities, so that the *gases* may *escape*, it does *more toward keeping a body* than *four fifths* of the *fluids* used by the undertaker of to-day, as an intelligent practitioner has no doubt observed. The name derived is from (lympha, water.) They are also called absorbents.

The lymphatic system includes not only the lymphatic vessels and the glands through which they pass, but also the *lacteal* or *chyliferous* vessels.

The lacteals are the lymphatic vessels of the small intestines and differ in no respect from the lymphatics generally, except that they contain a milk-white fluid (the chyle) during the process of digestion, and convey it into the blood through what is known as the Thoracic duct, and join the vessels of circulation at the junction of the subclavian and jugular vein. The lymphatics are almost a complete network of minute vessels, very delicate and transparent, while the *glands are a mass of oily transparent and fatty tissues.*

ANIMAL CHEMISTRY.

The purpose of the present chapter, so far as our knowledge extends, is to describe the chemical history of those bodies which are characterized as being rather organized than organic; as constituting not merely a product of the vital operations of the being, but the mechanism itself by which these vital operations are carried on; as making part of the tissues essential to its proper organization and life; and as being, while in connection with the animal and participating in its life, protected from

the truly chemical reaction of their proper elements, which after the death of the animal, especially when in contact with air or water, rapidly assume singular forms of union, and breaking up the complex animal tissues into a crowd of binary compounds, under the change well known as putrefaction.

In connection with these substances which form the basis of the organs and tissues of the animal frame, will be brought under survey the processes by which, from the atmosphere or from the materials of our food, the substance of our organs is continually renewed, their growth provided for, and the conditions necessary for the continuance of life and health maintained.

Of Fibrine.—This substance constitutes the basis of the muscular tissue, and forms an important constituent of the blood. In the latter it exists dissolved during life, but separates after death or extraction from the body, producing, with the coloring material, the phenomena of coagulation. In the muscles, the fibrine is arranged in a truly organized and living condition, constituting the contractile fibres, in which it is so interwoven with nervous and vascular filaments as to render its isolation impossible. To obtain pure fibrine, therefore, we have recourse to blood, which, if immediately on being drawn, it be briskly agitated with a little bundle of twigs, does not coagulate, but the fibrine is deposited on the twigs in soft, tenacious masses, which, being washed to remove any adhering coloring matter, and digested in alcohol and ether to remove any traces of fatty substances which may adhere to it, constitute pure fibrine, which may be dried by a gentle heat, and appears then, as a yellowish opaque mass, hard, tasteless and inodorous. If it be at all transparent, this results from traces of adhering fat. It is insoluble in water, alcohol and ether; it absorbs, however, so much water as to treble its weight, and thereby recovers the volume, softness and flexibility it possessed before being dried.

If sulphate of soda or nitrate of potash be added to newly drawn blood, its coagulation is prevented; and if fibrine be digested in a strong solution of nitre, it dissolves, forming a thick liquid, which is coagulated by heat, by alcohol, by acids, and is precipitated by the *salts* of *mercury*, *lead* and *copper*, and by prussiate of potash. This property of fibrine will again come under our notice.

Of Albumen.—This substance is even more extensiveiy distributed through the animal frame than fibrine. Like fibrine, it exists in two conditions, one soluble and one insoluble in water; but whereas the fibrine becomes insoluble almost instantly on being withdrawn from the body, albumen may retain that state for an indefinite time, and its history is therefore more complete. In its soluble form it exists in the blood, in the serous secretions, in the humors of the eye; in the soluble or coagulated form, it constitutes a portion of most of the solid tissues.

Soluble Abumen.—This is obtained in the solid form by evaporating to dryness, at a temperature which does not exceed 120° F., the serum of blood; the dry mass is yellow, transparent, hard, tough, and contains, besides the albumen, the salts and some other constituents of the blood in minute quantities; these are extracted by digestion in alcohol and ether, which leaves the albumen pure. When thus completely dry, it may be heated beyond 212° F. without passing into the coagulated condition; if digested in cold water, it gradually swells up and finally dissolves. This solution, when heated to a temperature between 140° and 150° F., coagulates; if diluted, the solution may even be heated to 165° without coagulating, and when present in a very small quantity the albumen may not separate until the water boils.

When once coagulated in this manner, albumen is totally insoluble in water; it is then changed into its second form. The solution of albumen is precipitated by *alcohol*, by *acids* and *metallic salts*, exactly as the solution of fibrine in *saltpetre;* the only distinction that can be drawn between the two is, that the saline solution of fibrine is partially decomposed by the addition of a large quantity of water.

The precipitates yielded by a solution of albumen with metallic salts are mixtures of two distinct substances, one a compound of albumen with the acid, the other a compound of albumen with the metallic oxide; the former is generally somewhat soluble, the latter insoluble. hence the result of the application of albumen as an antidote to mineral poisons, as corrosive sublimate and blue stone. Albumen is also coagulated by many organic bodies, as *tannic acid* and *creosote*, which acts catalytically, as a very minute quantity of it coagulates a large quantity of albumen without entering into combination with it.

Of the Gelatinous Constituents of the Tissues.—When the skin, cellular or serous, tissues, tendons, and some forms of cartilage, as that of bones, are boiled in water, they dissolve in great part and form a solution which gelatinizes on cooling. Some of this tissues, as the skin, dissolve easily and almost completely; others dissolve but partly, and leave behind a quantity of coagulated albumen. In most kinds of cartilage a very prolonged boiling is necessary to extract a sensible quantity of gelatine. These various tissues are thus found to consist of albumen and gelatine, united in various proportions, and each presenting various degrees of condensation of texture, but by boiling, they may be completely separated from each other.

Gelatine is insoluble in *alcohol* or *ether*. When a solution of gelatine is long exposed to the air, it undergoes a commencement of putrefaction, and loses its property of gelatinizing.

The action of reagents on gelatine is in some cases of high interest; it is not precipitated by solutions of either *ordinary* or *basic alum*; but if a solution of *common salt* be *also mixed*, the gelatine falls down, combined with alumina, as it decomposes the muriate of ammonia which is then formed. On this principle is founded the manufacture of white leather, by a kind of tanning with alum.

The most important compound of gelatine is that with *tannic acid*, which constitutes ordinary leather; this reaction is so distinct that one part of gelatine in five thousand of water is at once detected by the infusion of galls.

Many chemists consider that gelatine is merely a product of the decomposition of albumen and fibrine by boiling water, and not a true constituent of the tissues; but this idea is thought to be incorrect, on the following grounds: First, pure fibrine or albumen gives no gelatine by boiling; Second, in the process of tanning, the tannic acid combines with gelatine in a skin which has never been boiled; and third, that we can easily understand why some tissues give more gelatine than others by the different degrees or condensation of their structure. But it is rather considered that gelatine bears the same relation to the tissues of the skin that proteine does to the fibrine of the blood, being really a product of its death and decomposition, through the *only representative of it which we can have.*

The Fatty Constituents of the Tissues.—The fatty bodies, although contributing essentially to the support of the animal frame, are mere secretions, and do not form any portions of its organized tissues. The substances properly included under the present head are the constituents of the nervous tissue, such as it is found in the *brain*, the *spinal cord* and the *nerves*.

In the composition of the brain it is easy to distinguish three, perhaps five, distinct substances of a fatty nature, the most characteristic and important is called cerebrote; in composition it resembles albumen, containing a large quantity of nitrogen.

Saline and Extractive Constituents of the Tissues.—We find in all animal tissues small quantities of a great variety of salts, the same as those which will be hereafter noticed as existing in the blood, to the presence of which in the substance of the tissues they are probably due. In the tissue of the bones and teeth, however, these saline matters are deposited in much greater quantities, and in disease and old age bony deposits occur in all those tissues, which yield true gelatine on boiling. The composition of the bones will be hereafter noticed.

Of the Composition of the Tissues and of the Secretions in Health and Disease.—Having described thus individually the constituents of the tissues, we shall now present such results as have been hitherto obtained as to the quantitive composition of the organized tissues formed by their reunion, the secretory products and morbid alterations.

The *skin* of animals is a congeries of finely constructed organs, sensitive and secretory, imbedded in a peculiar tissue, which is one of those most yielding gelatine, whence the process of tanning skins. On the surface of the skin there is secreted a substance, which, though varying in anatomical structure and appearance exceedingly, as it *forms* the fine epidermis, the nails, the hair, etc., is yet throughout all their shapes identical in chemical character and may be described as the same substance. The principal mass of hair is composed of the same substance as horn, but the color is due to an oil which may be extracted by ether. If by virtue of the sulphur contained in hair, a solution of litherage in some limestone water blackens it, a solution of nitrate of silver will also blacken the hair, but by a deposition of the metal.

The prespiration from the skin varies in nature according to the part of the body; it is generally acid, contains traces of albumen, fatty matter and the salts of blood; it often contains also an odoriforous, volatile principal, characteristic of the animal by which it is secreted.

Cellular and Serous Tissues.—These tissues are constituted of gelatinous materials similar to that in the skin, and hence dissolve by boiling water, being converted into gelatine. In the natural condition of these membranes, their surface is moistened by a watery liquid, which, accumulating in excessive quantity, gives rise to the dropsies of the cavities or of the cellular tissues. This serum of the cavities is clear and colorless. The cells of the cellular tissues, in which fat is usually deposited, are often filled up by an albuminous material having considerable anagoly with casein; it is thus that the diffused hardening of the cellular tissue and the local white tumors have their origin.

Of the Muscular Tissue.—From what has been already said of fibrine, it is evidently the essential element of the muscular tissue, and forms with water almost the whole of their parts.

Of the Bones.—In vertebrated animals with osseous skeletons the earthly materials in all cases consists principally of phosphate of lime with phosphate of magnesia, carbonate of lime and soda. By digesting a bone in dilute muriate acid, all of these inorganic salts are removed and the cartilage remains, preserving perfectly the form of the bone.

The teeth present in their combinations, the greatest analogy to bone; the principal and organized substance of the teeth is indeed true bone, containing less cartilage and more phosphate of lime than other bones. The enamel, which is an organic secretion from the surface of the long tooth, is almost destitute of any animal mater.

Of the Composition of the Blood.—Blood is, in the higher classes of animals, an opaque, thick, red fluid; it has a salty and nauseous taste, and a peculiar smell, resembling that of the animal whence it has been derived.

When the blood of any red-blooded animal is allowed to rest, it gradually forms a soft jelly, from which, after some time, a thin yellowish fluid (serum) separates, while the red jelly or coagulum contracts in volume and acquires great consistence.

If this coagulation of the blood takes place slowly, the upper portion of the coagulum becomes white or pale yellow; forming thus the buffy coat. There is no doubt that the blood, while in connection with the animal, participates in its life, and the phenomena of coagulation are to be referred to a new arrangement of its material conseqent on the loss of that vitality.

The serum of the blood, when coagulation has been perfect, is of a yellowish (sometimes greenish) color, its taste is dull and salty; it is a thick fluid like olive oil. When heated to 140° F. it coagulates.

If we examine under the microscope the appearance presented by blood, we find that it consists of a great number of particles, swimming in a nearly colorless liquor. These red particles are flattened discs; in man they are round. Their size is variable, being in man from one four-thousandth to one eight-thousandth of an inch in diameter, but larger in other animals.

The blood contains a large quantity of *albumen*, partly dissolved and remaining in the serum after coagulation, partly in a solid state, forming the great mass of the globules.

In the living body the blood also contains fibrine in solution, but this separates soon after extraction from the body; it assumes a solid form, and investing as a sponge, the red globules forms with them the coagulum.

The fibrine is thus the element active in the coagulation of the blood, the globules being but passively engaged in it. In addition to this essential organic element, the blood contains a variety of salts, as common salt, phosphate of magnesia, ammonia and lime, lactates of soda and magnesia. The best analysis of the blood are those of Lecanu, and the results for blood and serum are, that they contain in the human subject of each sex: Water, 75.00; Albumen, 5.00; Globules, 7.14; Fibrine, 0.20.

The fatty substance of the blood is a mixture of cholestine with stearic and oleic acid and a peculiar fatty substance termed seroline, the history of which is yet incomplete. None of the fats of the brain, however, seem to exist in the blood.

The chemical history of fibrine and albumen having been already given, it remains only to describe the peculiar coloring matter, for the most accurate knowledge we possess concerning which, we are indebted to Lecanu's elaborate researches on the blood. Pure hematosine or coloring matter, when it is coagulated,

is a dark brown mass, tasteless, and inodorous; when heated it does not smell, but swells up and evolves ammoniacal products. It is insoluble in water, alcohol and ether; *it forms with the mineral acids, compounds which are insoluble in water, but soluble in alcohol.*

By caustic alkalies it is dissolved with a red blood color, and these combinations are soluble in water, alcohol and ether. Hematosine contains neither phosphorus nor sulphur, but iron in large quantities. The state in which iron exists in hematosine has been, up to the present day, an object of much discussion among chemists; but with the knowledge we now possess of hematosine in its pure form, we must consider the iron to be an integral part of its organic constitution, as sulphur in albumen, or arsenic in alkarsine, and the opinion of its being oxydised and combined with the true organic element as a kind of salt can no longer be supported. If a solution of hematosine be acted on, by chlorine gas, a white flocculent precipitate is produced, and the solution contains chloride of iron.

Although hematosine is the coloring principle of the globules of the blood, it is present but in a very small quantity; one hundred parts of dried globules containing but four to five parts of hematosine; in the blood globule the hematosine exists in its uncoagulated state, and possesses properties somewhat different from those of its coagulated form.

A solution of the colored blood globules in water, when exposed to the air, becomes of a brighter red color, being thus partially arteralized; *it is coagulated also by alcohol and acids;* the hematosine then passes into the condition of insolubility, already described.

The colorless ingredient in the blood globules has already been spoken of as being albumen, with which indeed it is identical in properties, but differ in some points. It has been termed globuline. In its uncogulated condition it can not be separated from hematosine, and is there distinguishable from albumen, principally by being insoluble in even a very dilute saline solution, which dissolves albumen readily. It is, hence, that the globules of the blood swim unaltered in the serum, but are readily dissolved by pure water.

If the blood, when extracted from the vein, is received into a vessel containing a solution of glaubers salt, coagulation is pre-

vented, as the fibrine remains dissolved, and by filtering the liquor so obtained, the serum and water pass off, and the globules remain mixed only with little of the salt. The globuline cannot, however, be separated from hematosine, except by acids, which, as described in the preparation of hematosine, then combine with the globuline.

Alteration of the Blood in Disease.—The examination of the state of the blood in disease, although presenting important relations to pathology and to practice, has been conducted in a manner too disconnected and superficial to produce any satisfactory results. This branch of chemical pathology has, however, been taken up by the illustrious Andral and Gavaret, who have published the result of the analysis of the blood in three hundred and sixty cases of disease.

Their researches have enabled them to recognize four classes of diseases, in which the composition of the blood is essentially altered, though in different ways.

The first class presents as a constant alteration, an increase in the quantity of fibrine; it includes diseases remarkably different in their locality and form, but all belonging to the class of acute inflammations. In some cases of morbid deposition, as in tubercle and cancer, a similar increase in the quantity of fibrine is found, but it may be doubted whether it be due to abnormal growth, or to the inflammatory action which accompanies it.

In the second class, the fibrine remains stationary, or even diminishes in quantity, while the globules increase in proportion to the fibrine. The diseases which belong to this class are continued fevers without local inflammation, and some form of cerebral hemorrhages.

Cerebral Hemorrhages.—In the third class, the fibrine remaining unchanged, there is a remarkable diminution in the quantity of globules; of these diseases, chlorosis may be taken as an example, and in the fourth class, it is no longer the fibrine or the globules which are the subject of the morbid change, but the quantity of the albumen in the serum is diminished; of this class of affections is Bright's disease.

It has been observed, that in cholera the blood becomes so thick as to arrest circulation, and contains from thirty to forty-five per cent. of solid matter; it is then, also, less alkaline than healthy blood; this is connected, probably, with the matters

vomited and evacuated, which are strongly alkaline, and contain a quantity of albumen.

The blood has been found, occasionally, in cases of Diabetes Mellitus, to contain traces of sugar. The great discordance of the results obtained, may result, perhaps, from the sugar contained in the blood only for a short time after meals and being rapidly evacuated by the kidneys. In jaundice, the green coloring matter of the bile has been found mixed with the blood. Other observations of morbid constituents of the blood are too indefinite to justify me in occupying space with them.

Color of the Blood.—In the living body, the blood in the veins and arteries is well known to differ essentially in color; in the former being of a dark purple-red, in the latter of a bright vermillion color. The change from the venal to the arterial state occurs during the passage of the blood through the capillary vessels of the lungs, where it is exposed to the action of an extensive surface of atmospheric air; while the arterial blood, in traveling the general capillary system of the body, assumes the red, dark condition in which it is carried back to the heart by the veins. Yet, although the vital properties of the blood depend essentially upon this change of color, we are not able to connect it, with any alteration in the composition of the constituents of the blood, or even in their relative proportions. Arterial and venous blood contains sensibly the same quantity of water, fibrine, globules, albumen and salts; and, by analysis, the composition of those bodies is found to be identical, no matter what kind of blood they may be derived from. To trace the difference of nature between arterial and venous blood, it is therefore necessary to study it under different points of view than its approximate or elementary composition. So far as we have yet explained it, the air which has been employed in respiration, is found to have undergone an important change of constitution; its volume is but slightly, if at all, altered; but a quantity of oxygen has disappeared, and is replaced by carbonic acid, in general equal volume. Air which has been once respired, is found to contain from three to four per cent. of carbonic acid, and if the same quantity of air be continually breathed, the animal dies with all the symptoms of narcotic poisoning. When the carbonic acid has accumulated to from eight to ten per cent., the action of the air in expiration is therefore to remove carbon from the blood.

The quantity so taken from the system in twenty-four hours is very large, and makes up the principal portion of that element which we take in, with our food; yet, such is the activity with which its assimilation provides, that no perceptible change in the solid elements of the blood can be perceived.

It was, at one time, a much disputed point, whether the carbon so separated from the system was directly exerted from the lungs, and carried off as it were, by contact of the oxygen of the air, or whether the oxygen was first absorbed by the blood and carried by the circulation to every portion of the body, where it combined with the carbon, which was there present in excess, and the carbonic acid so produced, being dissolved by the venous blood, was thrown off on arriving at the surface of the atmosphere in the lungs. The progress of science has, however, finally decreed in favor of the latter view, to which the fullest confirmation has been given by the careful and elaborate researches of Magnus.

Gases in the Blood.—It was found that both arterial and venous blood contain dissolved quantities of gases, oxygen, nitrogen and carbolic acid, which amount to from one-tenth to one-twentieth the volume of the blood; the proportions of these two gases to each other are different in arterial and venous blood; the oxygen in arterial blood being about one-half of the carbonic acid, while in the venous blood it seldom amounts to more than one-fifth; the difference is greatest in young persons, and probably is proportional to their activity of nutrition. The quantity of nitrogen appears to be the same in both kinds of blood, making from one fifth to one-tenth of the gaseous mixture.

The physico-chemical conditions of respiration are simply explicable upon these results, by the principle of gaseous diffusion, the fine lining pulmonary membrane being permeable to gases. When the venous blood arrives at the surface of the lungs, a portion of the carbonic acid which it contains is evolved, and a quantity of oxygen gas absorbed in place of it; these two quantities are not necessarily equal at each moment, though ultimately they become so, and hence, the volume of oxygen absorbed is generally, though not universally, equal to that of the carbonic acid given out. There appears, from the presence of nitrogen in equal quantity in both kinds of blood, to be an absorption and evolution of that gas, simply from physical laws and independent

of any application of it to the nutrition of the animal; hence the volume of nitrogen in air is sometimes increased, and at others diminished by respiration, and a man evolves much nitrogen when respiring an atmosphere of oxygen and hydrogen, while it has been shown that the rate of nutrition of a man is proportionate to the quantity of nitrogen it receives as food, and that none of that principle is really assimilated from the air.

It is still by no means easy to decide upon the changes of color which occur in the blood during respiration; for this should appear connected, not merely with the presence of certain gases in the blood, but upon a true change into the composition of hematosine, which analysis cannot direct.

Stevens first attracted the attention upon the influence which saline bodies have upon the color of the blood. If dark, venous blood is put in contact with a solution of common salt, glauber salt, nitre or carbonate of soda, it becomes as vermillion colored, as if it had been truly arterialized; on the contrary, the presence of carbonic acid impedes this action, and gives to blood, so reddened by salt, not in excess, the dark tint of venous blood.

If we consider, therefore, the arterial tint to be due to the material combination of the coloring matter with the saline constituents of the serum, this will be darkened, when, by passing through the capillary system, the blood takes up an excess of carbonic acid; and again, in the lungs, when the carbonic acid is replaced by oxygen, the vermillion color is restored, not by any active agency of the oxygen, but by the natural tint of saline hematosine becoming evident.

Although this theory of the change of color is by no means free from objection, it appears to be better founded than any other that has been proposed.

Animal Heat. — The phenomena of respiration consisting mainly in the convertion of carbon into carbonic acid, by union with oxygen, the heat which is developed in the body of all red blooded animals has been naturally referred to that source; and as we know that the change from the arterial to the venous condition of the blood occurs at every point of the system, the almost complete equality of temperature throughout the body in health is explained. That the great source of heat is the respiratory process, is abundantly proved by the temperature being highest in those animals, and in the same animal, at those periods when

the circulation is most rapid and the quantity of air consumed the greatest. But it has been calculated that the heat evolved by the combustion of the quantity of carbon thrown off from the body in twenty-four hours is no more than eight-tenths of the quantity generated in the body during that time, and the origin of the remainder must be found in the action of the muscles and the nervous power, which appears of itself to be a distinct source of animal heat.

COMPOSITION OF THE DIGESTIVE ORGANS AND OF THEIR SECRETIONS—CHEMICAL PHENOMENA OF DIGESTION.

Mucus.—The living membrance of the alimentary canal is moistened with a liquid possessing many of the characteristics of vegetable mucus, but containing nitrogen. It is a thick, tenacious substance, which contains, dissolved in the water through which it is diffused, the ordinary salts of the serum of the blood; it swells up with water to a considerable mass, but without dissolving. It dissolves in alkaline liquors, and is precipitated therefrom on the addition of an acid and the tincture of galls; the mucus from different parts of the mucus membrance is, however, by no means identical in properties.

The liquid secreted by the internal surface of the stomach—the gastric juice—which exercises an important influence on digestion, differs essentially in its character from mucus. When the stomach is empty and contracted, it contains ordinary mucus; but if even indigestible substances are introduced, and still more after taking proper food, a liquid is abundantly poured out, which is colorless or pale yellow, and contains a very small quantity of solid matter (two per cent.), which consists principally of inorganic salts (common salts and sal-ammoniac, with a trace of salt of iron); it is specially characterized by the presence of a notable quantity of free muriatic acid, the proportions of which vary with the activity of the digestive powers at the time. This gastric juice possesses the remarkable property of softening down and dissolving fibrine and albumen, and thus converts the masses of food into the uniform pulpe (chyme), from which the absorbing vessels of the small intestines, take up the nutritous elements.

If we form an artificial gastric juice by mixing together the muriatic acid and salts in the right proportions, it is found to be totally incapable of dissolving the materials of the food, and in-

deed to be quite inactive towards digestion. The organic material of the gastric juice, although its quantity be so minute, is therefore, essential to its powers, and these may be perfectly conferred upon the previously inactive, artificial juice, by the addition of a little of the mucus of the stomach or by steeping in the acid liquor, for a short time, a small portion of a mucus membrane, and filtering the liquor; for this purpose it is not even necessary to use the mucus membrane of the stomach, for that of the bladder has been found to answer equally as well. The substance which is dissolved out of the membrane in these cases has been termed pepsine. It has not been obtained in a truly isolated or pure form, but its properties are very remarkable. For its full activity it requires the presence of a free acid, as the artificial gastric juice becomes much less active in dissolving food when neutralized by an alkali, though it retains other properties, as that of coagulating milk-like rennet. If the artificial juice be precipitated by nitrate of lead, the precipitate washed, and then decomposed by sulphuret of hydrogen, the solution thus obtained possesses all the digestive powers of the juice. Hence the pepsine and *muriatic acid* act together, by combining with *oxide of lead.* Pepsine appears to be completely decomposed by contact with alcohol or boiling water; its powers are also destroyed by deodorizing substances; the solution of albumen and fibrine in gastric juice differs essentially from their solution in muriatic acid, as in the former case the quantity of acid is very minute, in relation to the quantity of material dissolved, and after solution the acid remains quite uncombined.

The action of the stomach in digestion, appears therefore, as far as our actual knowledge extends, a purely catalytic fermentative action; one in which the active excitant is an organic substance (pepsine) secreted by the mucus surface, and whose properties are developed by the presence of muriatic acid, which is secreted at the same time. The new products into which the food, fibrine, albumen, gluten, starch, oils, sugar, etc., are converted, and which collectively constitute the white uniform pulp, termed by physiologists chyme, have not been made the subject of accurate chemical researches.

In the mouth, a mass of nutritive material is acted on by a liquid which is secreted by the salivary glands, the saliva. It is alkaline and holds in solution not one per cent. of solid matter,

which contains some carbonate of soda and common salt, admixed mucous, and a peculiar organic body, termed salivary matter.

This last substance is soluble in water, its solution is not coagulated by heat, nor precipitated by tincture of galls, corrosive sublimate, acetate of lead, nor by acids. The pancreas so similar in structure to the salivary glands, has a different secretion; it contains no salivary matter, but albumen and some salts; it is generally slightly acid.

Composition of the Bile.— The precise part, which this remarkable secretion performs in the animal economy is not yet fully known; it has been the subject of repeated and accurate chemical examination, although, from the facility with which its elements are transferred into other bodies, by the action of the reagents employed, every succeeding analysis has led to different results.

The Coloring Matter of the Bile.— This is present during health only in a small quantity, but in disease it somtimes accumulates so, as to form solid masses. When pure, it is a reddish-yellow powder, which is scarcely soluable in water or in alcohol, but dissolves easily in a solution of caustic pottash. This solution is of a clear yellow color, but when exposed to the air it becomes deep green, absorbing oxygen. This change is remarkably produced by nitric acid, and it is indeed the reaction by which the presence of the bile in the serum of the blood, in the skin, in the urine, and eyes etc. may be shown in cases of jaundice.

Chyle and Lymph.— The nutritive materials extracted from the food by the absorbing vessels of the intestines, is thrown into the thoracic duct, where it meets with another fluid, which is transmitted to the same vessel from all parts of the body, by the colorless veins or lymphatics. The fluid from the intestines is termed chyle; that from the body is generally termed lymph. It is the mixture of these that has alone been examined, for the vessels which carry either separately are too minute to allow of the extraction of their contents in a pure form.

When taken from the thoracic duct a few hours after a meal, when, probably, the chylous element prevails, it is whitish, opaque liquid like milk with generally a reddish shade; a short time after separation from the body, it coagulates; the clot is at first pale,

but it soon becomes light crimson red; the milkiness of the serum is due to the presence of oil; it contains albumen and coagulates by heat; except that it is more dilute, and that the lematosine is for the most part absent, the chyle and lymph have the same composition as the blood. It appears to vary, however, with the nature of the food, as Dr. Prout found the chyle of persons fed on vegetables to contain a much smaller quantity of albumen than when they had, had animal food.

Dr. Prout also indicates in chyle the presence of a substance which he terms incipient albumen, which is not coagulated by heat, except after the addition of acetic acid; the properties of this form of albumen, however are not fully known.

Constitution of the Urine in Health and Disease.—The nature or their secretion has at all times been an object of considerable interest to the chemist, from the indications which changes in its composition given of diseases, of important organs and from the number and interest of the different organic substances it contains. As in almost all other branches of animal chemistry, Burzelius first determined its composition, and lately Lecanu has ascertained with great care the limits to which the proportions of its ingredients may vary in health, and this established a correct basis of comparison for urine in the various conditions of diseases.

Of the Urine in Disease and after Death.— Urinary Calculi.— To the chemist, the indications of disease of the urinary and digestive organs, formed by changes in the composition of the urine are most valuable. The majority of the substances which are taken into the circulation, but are incapable of assimilation to our organs, are thrown off by this secretion, and hence a variety of medicinal substances may be traced to it, after having been ingested, sometimes quite unaltated, at others modified in their nature. Thus if alkaline salts of organic acids be taken into the stomach, the organic material is oxidized, probably during the action of respiration, while the alkali passes into the urine in the state of carbonate. If however the organic acid be taken uncombined, it escapes decomposition, and passing into the urine, produces an abundant precipitate of salts of lime. In the case of the tartaric acid and oxalic acids, some organic bodies, as aspharagine and the oil of turpentine, are decomposed,

and the products which they form are excreted, giving to the urine peculiar odors; in the latter case like that of violets.

The majority of coloring matters are thrown out of the system by their secretion, while others are not so given off.

The mineral acids — alcohol — camphor and most metallic salts—do not pass into the urine to any sensible degree.

Urine in Diabetes.—The most remarkable change in the nature of urine occurs in Diabetes Mellitus; it is voided in great quantity; it is found to contain a great quantity of grape sugar, and very little urea.

It was supposed that in this disease urea ceased to be formed by the system, and was replaced by sugar; but it has been shown that, although the quantity of urea is very small in any one specimen of urine, yet the total quantity is so much increased, that in twenty four hours the natural quantity of urea is secreted; the secretion of sugar being an act of faulty digestion, and totally unconnected with the urea. These results have been fully confirmed by experience, The diabetic urine sometimes contains albumen, which arises from complications of other forms of disease.

All that has been said in the former chapter about the solid and fluid constituents of the human body may, at first sight, and to a great many seem to be superfluous and out of place in a work of this kind. It is true that the different modes of preserving bodies, as explained in the book, do not require this long dissertation of animal chemistry in order to be understood; still, when we consider that the chemicals used in these different processes have an object to accomplish, it must be granted that a thorough knowledge of the constituents of the body, their composition and chemical proportion, will, to a great extent, explain the reason why these same chemicals are used in preference to others.

The secondary object, which is not less important, consists in the fact, that a thorough knowledge of the animal chemistry of the human organism is most necessary to understand the different changes which takes place in the formation of the different juices and tissues of the body, when they enter into combination with the chemicals, the object of which is, to render them imputrescible.

However, the study of these combinations affords a simple and clear explanation of the means resorted to, in order to preserve bodies.

ANIMAL MATTER—DISEASED OR PUTRID.

Infection through the action of diseased or putrid animal matter, either by inoculation or otherwise, will be exemplified here, in its proper bearing and direct relation to the professional duties of the undertaker. Of animal substances rendered poisonous by diseases, we have instances in the several matters by means of which contagious and infectious diseases of a definite character are propagated. But the examination of these belong to the practice of medicine and not to the undertaking profession. We shall, therefore allude to those only which are occasionally developed, and which seem to act the part of irritant poisons.

When cattle are over-driven and killed, though their flesh does not produce any disagreeable effects when eaten, but, if externally applied when in the raw state, to a wound, however small, a diffuse inflammation is the result, which has sometimes destroyed life. The purulent matter discharged from the nostrils of glandered horses presents us with an instance of similar kind. When this matter is applied to the hand by inoculation, inflamation of the part and an eruption of carbuncles is the consequence; and there are even well authenticated cases of the disease having been taken by grooms without inoculation. The most interesting example however, of poisoning to be traced to a virus, resulting from a morbid action, is that with which we are so familiar, as a consequence of wounds, incurred in dissection. The effects to be observed in such cases cannot be referred to animal matter, in a state of spontaneous decomposition, for they are never found to occur, unless at so early a period after death, as to preclude the possibility of ordinary putrefaction having been established. Experiments also, would seem to prove, that they are more frequently produced *by the fluids effused in the chest and abdomen*, as a consequence of inflammation, than by any other of the solid or fluid constituents or secretions of the body.

The symptoms which usually set in are briefly as follows: In a few hours after the reception of the wound, an acute pain is felt at the tips of the shoulder, and a swelling, at first colorless, is observed on the lateral part of the neck, between the trapezius and sterno-mastoid muscles, which is acutely sensible upon pressure. At first the wound exhibits no unnatural appearance, but some time after the occurrence of the symptoms just stated, it is found covered with a small pustule containing a milky fluid. The pain and swelling at and above the shoulder now become worse, and extend to the axilla, from thence to the thorax, and down along the side; and a similar species of diffuse inflammation seizes upon the arm and forearm, following the course of the great absorbent vessels. This inflammation Mr. Collis conceives to be a species, *sui generis* quite different from phlegmonoïd erysipelas. Toward the close of the attack, particularly when the termination is unfavorable, a few pustules similar to that upon the wound appear in other parts of the body, and the skin of the inflamed regions is studded with little solid elevations, which at first sight are taken for vesicles; the constitutional invasion is sometimes, though not always, ushered in, by distinct rigors and vomiting, and a low typhoid fever, of the most malignant type, is present from the very commencement. Several individuals eminent for their anatomical zeal and scientific acquirements, have fallen victims to this formidable malady, amongst whom was the late Mr. Skekleton, museum curator to the Royal College of Surgeons in Ireland. An account of his case with some other of a similar description, has been published by Mr. Collis in the Dublin Hospital Reports, (volumes 3 and 4.) No lesions of internal organs have been traced to their affection. After the reception of a cut or puncture either, in dissecting or in embalming, the part should be rendered as clean as possible by soap water, and a cupping glass, or the mouth, which will answer better, should be applied, until by suction, a considerable quantity of blood is drawn, and the surface of the wound entirely freed from foreign matter. These prophylactic measures will, generally speaking, be sufficient; but for greater security, it will be advisable to apply the potassa fusa or aqua fortis to the wound, with a view of destroying any of the poison, which may not have been previously removed, or at least of modifying the inflammation which may follow:

When the hand and arm have become swollen, and the fever already described has set in with violence, the treatment which has been found most beneficial consists in the free administration of opium, port wine, and other stimulants, the inflammation being at the same time combatted by the usual application. Mr. Collis, on general grounds, but without any experience of its efficiency recommends calomel in repeated doses, so as to produce rapid salivation. The effects just examined are the results of inoculation with animal matter, modified in a certain manner by circumstances not well understood, but not at all in a state of decay or decomposition. Animal substances, however, in the putrid state, possess similar powers, as has been proved by the experiments of Orfila—that is, when introduced into a wound, they excite diffuse inflammation, and at the same time, fever of the typhoid type.

ANIMAL MATTER—PRESERVATION AND PUTREFACTION.

From the great complexity of the composition of animal substances, their decomposition is more rapid and its products more diverse than in the case of organic bodies of vegetable origin. While the carbon, hydrogen and oxygen give origin to the various kinds of ulmine and other substances of the same class, the nitrogen is generally valued as ammonia and the sulphur as sulphurated hydrogen. It is the presence of these bodies that give to the putrefying substances the disagreeable odors by which that process is distinguished from mere mouldering and rotting. Even during life the constituent particles of the body are in a continual state of change, being absorbed and thrown out of the system, while others are assimilated in their place. Any part of our constituents, liquid or solid, which become unfitted for this vital function, is thereby killed, and must, if not got rid of, induce the death of the individual. Hence, precisely the same means which give to the animal substance the fixity of constitution which belongs to true chemical compounds and thus preserve them from decomposition by the disturbing action of

their own elements (as when we coagulate albumen by an acid, by corrosive sublimate, or by sulphate of copper) produce, if applied to the living body, the death of the part or the whole being, by depriving the blood, or the tissue of the mutability of constitution, which is required for the functions of the animal frame.

It is thus that the generality of metallic poisons act in producing death. Being absorbed into the system, they unite with the albumen and fibrine of the blood, and converting them into the insoluble compounds which we form in the laboratory, unfit them for the continual absorption and secretive offices which, as organs, while they live they must fulfill. If the injury be local and limited in extent, the part so coagulated may be thrown off and after a certain time the functions return to their proper order. If the mass, or the importance of the affected parts be greater, the system cannot so get rid of the portions which have thus been removed from the agency of life, to submit to merely chemical laws; on the contrary, the vital powers of the remaining portions of the animal are so much weakened in the effort that general death is caused. *For putrefaction it is thus necessary:*

1st. That the force of vitality which governs so completely the mere chemical tendencies of the elements of our tissues be removed.

2nd. That there shall not be present any powerful chemical reagent with which the organized material matter may enter into combination and thus the divellent tendencies of the affinities of its elements be overcome.

3rd. That water may be present in order to give the necessary mobility.

4th. That oxygen be present, or at least some other gas, into the space occupied by which the gaseous products may be diffused; and lastly, that the temperature shall be within moderate limits, putrefaction being impossible below 32° or above 182° F.

The agency of the first of these preventive powers need not be further noticed. The second is extensively employed for embalming purposes and in the preparation of bodies for anatomical studies, by *baths*, or *injections* into the *arteries*, of solutions of corrosive sublimate, acetate of alumina, sulphate of iron, tannin, wood vinegar and creosote; this last body, however, does not appear to act by direct combination, but by the complete coagula-

tion it produces in all the tissues of the body that have protein for their base.

The necessity for the presence of water is shown by the fact that by drying the animal substances they are completely preserved. It is thus that the bodies of those perishing in the Arabian Deserts are recovered years subsequently, dried, but completely fresh.

Alcohol and common salt both act in the preservation of bodies by their affinity for water. If a piece of flesh is covered with salt, the water gradually passes from the pores of the flesh, and dissolving the salt forms a brine, which does not wet the flesh, but trickles off its surface; the water necessary for putrefaction is thus removed.

Fourth by excluding oxygen, the putrefactive process is retarded, precisely as the fermentative action of the gluten in grape juice cannot begin until a certain quantity of oxygen be absorbed. It is thus that meat, that is sealed up in close vessels and then boiled for a moment is preserved; the small quantity of oxygen of the air remaining then in the vessel is absorbed, and the product of that minute change being coagulated by heat, it cannot proceed farther.

A high temperature stops putrefaction by coagulating the azotised materials; a temperature below 32°, by freezing the water, acts as if the tissues had been dried; in both cases putrefaction is arrested.

During putrefaction, at a stage prior to any fetid gas being evolved, a peculiar organic substance is generated, possessed of intensely poisonous properties, and the blood of persons who have died from its effects is found to be quite disorganized and irritating when applied to wounds.

This and the blood of over driven cattle are found to produce effects similar to those of venomous reptiles and the wounds received in dissection are sometimes followed by similar fatal consequences. The communication of disease in this way has recently been very ingeniously ascribed by Liebig to the general principle of the communication of decomposition by contact.

The small quantity of diseased organic matter originally introduced into the system by absorption, acts as a ferment and reproduces itself in the mass of the blood, until this becomes unfitted for the performance of its functions and the animal is

killed; the active principle being thus copiously present, is exuded from the skin and lungs and gives a contagious character to the disease, or it remains only in the blood, or is secreted in pustules, constituting infection, by which the disease may be communicated to some other person.

This brief enumeration of the process of putrefaction will, to a certain extent, elucidate the process of embalming given in this book; it shows that the different methods herein explained, fulfill the conditions necessary to stop the progress of decomposition.

A most important point, and one which ought not to be passed upon, without serious consideration, is the communication of disease by contact and absorption.

RAPID DECAY OF THE HUMAN STRUCTURE.

Under this heading, we will present to our readers an essay upon the causes of the dissolution of the human body, by W. W. Ball.

As soon as the vital action ceases, decomposition ensues in the substances which were before, the very elements of life, viz: blood, lymph, chyme, chyle and gastric juice become active agents in its destruction. In the blood, the most important agent during life, as soon as life ceases becomes one of the first to produce that blackened putrid and sloughing condition we find shortly after death. The blood being left in every part of the body, it breaks up and forms new compounds, of which only a general outline is attainable, for want of definite chemical analysis or microscopical observation. The fibrine and serum separate; the former, which contains most of the red corpuscles, albumen, saline, and fatty substances, gelatinates or coagulates on the sides of the vessels themselves, while the serum permeates the surrounding tissues, uniting with oxygen carried off from the pulmonary structure during life, and these, having an affinity for the tissues, form these compounds termed sulphuretted and carburetted hydrogen gases, giving rise to that effluvium which characterizes deceased bodies.

CONDITION OF THE BLOOD.

After death the blood is found in two forms. This is owing to certain diseases and circumstances. The first is encountered when death has ensued after a long stage of sickness. The vital fluids become exhausted by disease, and the organs of circulation become too weak to perform their office of circulating the fluid they contain, hence, dissolution takes place in the blood from want of constant and rapid action. Thus the fibrine becomes lodged and coagulated in the veins and capillary system. The fibrine and serum separate, leaving the fibrine clotted, and the serum a transparent, fatty or oily liquid, permeates the tissues of the flesh. Usually the arteries are found without any blood remaining in them. In instances of this kind there will be no difficulty encountered from the corpse turning black, as the gases cannot force the blood to the surface into the capillary system; because the fibrine is lodged elsewhere, but the flesh may turn brown or saffron color to some extent.

DIFFICULT CASES.

The second condition of the blood is found when death resulted from accident or short duration of sickness. In these instances there is usually a large abundance of fluids remaining in the system. These foster fermentation in every structure, and evolve the gases so rapidly, as to cause the cavities of the thorax and abdomen to become extended to their utmost capacity with gases that induce the blood to leave the vessels in the thorax and appear at the surface in the capillary system. In this instance the fibrine and serum of the blood remain together in an inky condition. Thus it is observed that the gases are so rapidly evolved by the destructive fluids. that before the fibrine coagulates it is forced from the vessels of the thorax (especially the superior vena cava) and caused to appear above the surface into the neck and face. The great pressure of the gases depresses the vessels of the thorax in the same manner that it does the stomach when purging takes place, which occurs invariable whenever the stomach contains any movable matter. The lymph, chyle and chyme, which are the same or similar, as soon as death ensues takeon new molecular changes; the lymph especially, which is retained in all the glands and vessels of the lymphatic system, enter into the process of decomposition, fostering putrefaction in the whole structure; while the gastric

juice, a peculiar fluid so subservient to digestion, which affects the food only during life, immediately attacks the substances of the stomach when life is extinct in the same or similar manner as it affected the food during life, corroding and completely destroying everything with which it comes in contact, as there is no vitality to resist its action. Elements having other affinities and the organism generally, hurry back to their primeval state. Nature knows no delay. The work to be done is to disorganize the body and destroy its form. This is the work of heat, moisture, air and germs in unison causing the fluids and tissues of the body to decay rapidly, while the albumenoid matters are decomposed into fetid gases escaping in the air, which in a short time accomplish the work of dissolution, leaving the body a mass of corruption and the receptacle of myriads of germs of microscopic beings. The corpse is their natural aliment, and death their chosen laboratory.

The products of putrefying animal matter are carbonic acid, water, ammonia, and carburetted hydrogen gases which are generally mixed with various portions of phosphuretted and sulphuretted hydrogen gases. The blackened or mortified appearance in those instances is usually caused by the dark blood from the vessels of the thorax. The great pressure of the gases in the abdomen and thorax prevents the liquid from gravitating to the regions of the heart and large vessels, producing the black and livid appearance of the face and neck by its retention in the capillary system of the epidermis. Man has been facetiously described as twelve pounds of solid matter wet up with six pails of water; hence the great abundance of water in the human structure gives the necessary mobility for putrefaction. This is proven by this fact; that by drying the animal substances they are completely preserved. It is thus, that the bodies of those perishing in the Arabian Deserts are recovered years subsequently dried, but otherwise fresh and lifelike. This fact also proves that the climate of Asia is far more favorable for the preservation of animal substances than this country, and no doubt had a great deal more to do in preserving the mummies of the ancient Egyptians than any art, or untold science.

DEATH.

Physicians, and well as professional observers, are aware that there are two modes of death, the one more or less sudden, the other gradual. The former is the least common, and either takes place, as the termination of some extensive organic disease, seated in an organ directly essential to life, as in extensive cerebral hemorrhage and other injuries of the brain, rupture of the heart, aneurism of the aorta, etc., or else upon some sudden exertion during exhaustion from protracted disease, as occasionally happens in the last stages of pulmonary consumption, cancer, and in anemia. In these cases death is instantaneous, gives no warning of its coming, and takes place without a struggle.

The phenomena of gradual death vary a good deal in different diseases; it is a beneficient provision that the exit out of life should oftener be more terrible to the spectators, than to the patient; that before the struggle comes, which is to separate the body and soul, the one should be insensible to impressions, and the other unconscious of sufferings. Comparatively speaking, it is very unusual for the mind to remain unimpaired until death; the final struggle does not usually commence until coma has thoroughly blunted the perceptions. Then a clammy and cold sweat stands upon the skin, the respiration grows quicker and shorter, and seemingly anxious, but really automatic efforts are made to expel the mucus which chokes up the lungs, and begins to rattle in the throat; the artery at the wrist pulsates more rapidly, but with gradually decreasing regularity and strength, until it can no longer be felt; the hands roam about with an uncertain and tremulous movement, as if in search of something, and coldness seizes upon the fingers and toes, and slowly advances toward the trunk. In maladies, attended by much emaciation, the state of the countenance is that called Hippocratic, after the writer who first described it. It is attended by a total loss of natural expression of the face; the skin is dry, shrunken and pale, or of a yellowish, livid or leaden hue; the nose is cold, sharp, and has its extremity drawn to one side; the eyes are sunken, filmy, and half-closed; the temples and cheeks hollow; the ears shrivelled and retracted, and the lips and lower jaws completely relaxed.

The duration of this phenomena may not exceed two or three hours, or may last for one or two entire days. They are most frequently observed at the close of chronic diseases, but are occasionally met with in what is improperly called sudden death, but which is only a sudden and short disease. We allude to those cases of apoplexy in which death takes place within from *ten* to *twenty four hours* after the commencement of the attack. The progress of the mortal symptoms is often in such cases, precisely what has been described above.

By the publication of Bischat's masterly analysis, our knowledge of the mechanism of the act of death has been materially increased. We shall describe its principal varieties. There is *natural*, and there is *accidental death.* The former occurs in old age, and is marked by the steady and gradual decay of all the powers of life, organic as well as animal. As man advances to the natural limit of his earthly existence, he loses his means of intercourse with the external world; one by one all the avenues of sense are shut up, the eyes grow dim, the ears dull, and smelling, tact and taste are blunted; his mind, but feebly impressed with the objects and events around him, lies dormant, or is moved only by recollections of days long past; his tottering gait, his shrivelled and horny skin, his yearning for the fireside and the genial warmth of the sun, show how languidly the great functions of the circulation are performed; by degrees his digestion becomes impaired, and then decline proceeds more rapidly; innervation, colorification, absorption and secretion, all become embarrassed as the capillary circulation languishes; sooner or later this function ceases, and last of all the heart dies.

Death advances from the circumference to the center; frequently, it is true, old persons are cut off by definite diseases, and their mode of death differs in no essential respect from that of the young.

On the other hand, there are many sudden deaths in which the starting point and succession of the terminal phenomena of life can be distinctly traced.

In these, the cessation of function, which constitutes death, proceeds from the center to the circumference, commencing either at the heart, the brain, or the lungs. These three organs appear to be so directly and immediately essential to life, as to have been called figuratively, the tripod on which it rests. Yet

it must not be understood that they are alone essential, for, in the case of old age and that of many exhaustive diseases, death evidently commences in the parenchyma of the organs; the nutritive function is then the first to cease, and that, doubtless, because the blood has lost its healthful qualities. In various acute diseases, too, it is impossible to analyze the phenomena of death, so as to fix upon the organs in which it originates, and equally so, to ascertain the cause of its occurence. The following account of the modes of death is therefore to be received as the expression of what takes place in those cases only, which are susceptable of analysis in consequence of all the organs retaining their integrity, except the one in which the fatal process takes its rise.

Death commencing at the heart, or by syncope, is the most sudden form. The pulsations of this organ may be instantaneously stopped, and life extinguished like the light of a taper that is blown out. They may also decline more slowly and gradually; the former happens in wounds of the heart, in ruptures of its tissue, of aneurismal sac in its neighborhood, in mechanical obstruction of the passage of the blood through its cavities, and from debility of the organ. In most of these cases the cause resides in the heart itself; its function is destroyed by some remote cause affecting its mechanism or its vitality. In others, however, its function ceases, because a sufficient quantity of blood no longer reaches the interior of the organ, as in profuse hemorhage. The brain in common with the other organs is deprived of its due supply of blood, and sensation and voluntary motion are at once suspended; the lungs cease their motion immediately afterward, and the changes of the blood necessary even to the functions of organic life failing to take place, those functions can no longer be performed.

Death commencing in the lungs, or by asphyxia or suffocation, is owing to some cause which prevents haematoses. Extensive induration of the pulmonary parenchyma, tumefaction of the membrane lining the smaller bronchia, or the repletion of these tubes with mucus, etc., mechanical obstructions of every kind to the entrance of air through the larynx or trachea present instances of this cause. Owing to this influence, the venous blood instead of acquiring, in its circuit through the lungs, the qualities of arterial blood, is returned to the left side of the heart, and

thence distributed over the system, still loaded with the excrementitious matters, which should have been exhaled or revived by contact with the air. Such a fluid is deleterious wherever it moves; in the brain it destroys voluntary motion, sense, and general sensibility, and induces coma; it impairs even the exited movements of the respiratory muscles, thus allowing the lungs, the pulmonary artery, and the right side of the heart, to become gorged with blood; the last named organ receiving through the coronary arteries such an imperfect stimulus, soon loses its power of contracting, and then death is complete. This is perhaps the most ordinary mode of death in acute diseases, but its progress is often so gradual, and it becomes so involved with declining power of the brain and heart, as well as with the failure of the nutritive function, that to assign to each of these causes its appropriate phenomena, is perhaps impossible.

Death commencing in the brain, or by coma, is generally owing to compression. Depression of the skull, or a tumor of the minînges, by an effusion of serum, blood, or pus, in or upon the brain, or by excessive congestion of the cerebral vessels. This latter may arise from a great variety of causes, among which may be mentioned alcoholic and narcotic poisons; but this, perhaps, exerts in addition some injurious impression upon the nervous function. Loss of general and special sensation, of voluntary motion, and of consciousness, follow the action of any of these causes, but not always in the same order. Consciousness is, however, usually the first to fail, and then the several senses cease to perceive impressions distinctly, such, at least, is the case when death approaches slowly, in consequence of serous effusion; but, when more rapid in its onset, in apoplexy for instance, all the functions of the brain are suddenly abolished. Nevertheless, as was previous remarked, the patient may live internally for many hours and even days after the stroke, although he is to all appearance dead. Certain it is, however, that in death commencing with the brain, actual dissolution does not take place until the other *two* of the *triumvirate rulers of life* have lost their power.

Respiration first becomes embarrassed through paralysis of the respiratory muscles, asphyxia commences, and as it proceeds, the heart becomes gorged, and at last ceases to pulsate.

Thus, it will be observed, that however the act of death may

commence, it has one uniform termination,—cessation of the heart's movements. When the starting point of the mental process is in this organ, the result is generally so immediate, that no perceptible derangement, either of the brain or lungs, precedes it. In the exceptional cases, those in which the patient has lived for some hours after the rupture of the heart, or of the aorta, on reaching a certain degree, produces syncope, upon which, of course, death closely follows.

DEATH BY APNŒA. (PRIVATION OF AIR.)

DROWNING, AND IMMERSION AFTER DEATH—HANGING—SUFFOCATION —STRANGULATION—DEATH BY POISONOUS GASES— THE EFFECTS OF IMPURE AIR.

Mons. Tardieu, and some English authorities, object to these various modes of death being classed together; they attach more importance to the differences, than to the communities of these conditions, and it can not be denied that nearly all of them have something distinctive which warrants the separate treatment of each. On the other hand, the points of resemblance are many and striking; there is a practical convenience in commenting on the special circumstances of each fatal ending. In death by apnœa, we have, before life is extinct, lividity of the lips, fingers and other extremities, and in general of the whole face and other visible parts of the body; there are convulsive movements, which are at first more or less voluntary, though still instinctive or reflex struggles to breathe or to save life, and afterwards involuntary and unconscious spasmodic clonic movements of muscles and limbs, which are probably due to the stimulus of venous blood on the motor center of the brain and spinal cord; the veins become turgid; the pulse is at first full and compressible, but gradually becomes more feeble; there may be, and often is, frothing at the mouth; this froth may be tinged more or less deeply with blood; blood may escape from the nostrils, anus, vagina and other mucous membranes; urine, faeces and semen may be discharged involuntarily, and the heart no longer beats. This kind of death is more or less rapid—from two to five minutes is the usual time. In the case of drowning, apparent exceptions

are explicable by the occurrence of syncope at the post mortem examinations. We shall find in all of these deaths:

1.—More or less *lividity* of the lips, extremities and general surface, as has been described in life. In drowning, the face is often pale; sometimes it is so in hanging.

2.—*Hypostases*, or post mortem stainings, of darker color, than in some other forms of death.

3.—The venous system will generally be found gorged with a very dark color of blood; the arteries will for the most part be empty, especially in young persons.

4.—*Rigor mortis* is said to set in slowly, but the muscles become tetanized and remain fixed in that position. In hanging and other violent deaths, the genital organs are often turgid and erect, so that we get priapism in the male and an analogous condition in the female. In drowning, the penis is retracted and the scrotum shrunk, unless distended with gases from putrefaction.

5.—The blood iself will be found unusually dark in color, containing less oxygen and more carbonic acid; the blood is also unusually fluid in death by drowning; and in death by hanging we occasionally find the same post mortem results as in death by syncope. The heart may fail, and fainting occur in the first moments of immersion, or suspension, and thus nearly all the phenomena are changed. We shall deal first with the subject of

DEATH BY DROWNING.

We have here in most cases, two distinct sets of phenomena, viz. those due to suffocation, and those due to protracted immersion or submersion in the water. Some general considerations on this mode of death may reasonably precede more minute details. When a man, woman or child is thrown or falls into the water, he or she generally makes some efforts or struggles to save him or herself; if he be a swimmer, these efforts are intelligent, but he may, especially in cold stormy weather, soon become exhausted, or he may be seized with a cramp which so to speak, tetanizes his muscles, and this spasm may extend to the organs of respiration, and even to the heart itself; or fear, particularly if the dread of sharks or some dangerous spot be superadded, may induce syncope.

When a man falls, or is thrown into the water, he first sinks to a greater or less depth, but almost immediately rises to the

surface again, and if he is a swimmer, makes an effort to save himself, till at length he is reduced to the condition of one, who can not swim at all, with this difference, that he has already exhausted the strength which the other has in reserve for the death struggles common to both; these struggles consist of irregular movements of the arms and legs, and grasping of the hands at all objects within reach, whether floating in the water, fixed at the bottom, or growing on the banks. In the course of these irregular movements he rises repeatedly to the surface, tries to breathe, and takes in air and water, the contact of water with the windpipe causes a cough, by which part of the fluid is rejected, and with it some air from the lungs; this occurs again and again, until the body no longer rises to the surface; water alone is received in the vain effort to respire, while forcible, involuntary expirations continue to expel the air from the chest; at length all these efforts cease, the body sinks to the bottom, and bubbles of air are forced from the chest by the elastic reaction of its parietes; the water which has entered the mouth finds its way into the stomach, the rest into the lungs; and this residue, mixed with the secretion of the mouth and air passages, and frothed by the air inspired and expired, forms the foam so constantly met with in persons who have perished in this way.

POST MORTEM APPEARANCES ESPECIALLY DUE TO DROWNING.

1.—*Gooseskin, or cutis anserina*, is met with in many cases, yet it is not really pathognomonic of drowning, being met with especially in the lower classes, in other violent modes of death.

2.—*A livid, grayish blue color* of the hands and feet, like the cholera hand, or washerwoman's hand; the skin is wrinkled and corrugated, as well as cyanotic; this symptom needs from twelve to twenty four hours submersion. and may occur in bodies thrown in the water after death.

3.—*Contraction of the penis*, with retraction, so that the penis appears inordinately small, even in men of large structure.

4.—*Sand, gravel, mud, etc.*, may be found under the finger nails of the body; these are not always present, but when found may be of importance; sometimes fragments of sea or fresh water weeds may be found in the hands, as well as in the stomach and lungs.

5.—*Excoriations or abrasions* of the fingers are very common. As regards the condition of the eyes—they are sometimes wide

open, closed, or half open; the face is somewhat bloated, often pale.

6.—*Post mortem rigidity* is generally present.

7.—In cases of homicide or suicide, the hands and feet may be tied together, and weights attached to the body; if this has taken place during life, or whilst the body is still warm, we shall find similar appearances in the marks of the ligatures to those described under hanging and strangulation to which we must refer you. In cases of homicide (murder by drowning) there will probably be marks of other injuries, contusions, wounds, etc.

8.—There may be froth at the mouth and nostrils, and this may be blood stained; though very common, it is not peculiar to death by drowning. It is to be noted, however, that death by apnœa may be produced by a very small quantity of mud or water in feeble or intoxicated persons. The internal appearances of death by drowning belong more to the medical student.

If, on the other hand, you find marks of a cord around the neck (see hanging,) gun shot wounds, stabs in vital regions, or traces of poison, you may reasonably conclude that the body has been thrown into the water after death. In this case, in ad-has dition to putrefactive phenomena, there may be those due to imbibition.

DEATH BY HANGING.

As in the case of drowning, so in hanging, death does not always take place exactly the same way; whilst asphyxia or apnœa—death beginning at the lungs—is very common; death by *cerebral hyperœmia* or death beginning at the brain, and a form combining these (asphyxia with apoplexy,)death due to syncope, and death from injury to the spinal cord and vagus nerve in the neck, are also met with. It is well to establish here these differences as we shall again find them in the post mortem appearances.

POST MORTEM APPEARANCES IN DEATH FROM HANGING.

Omitting almost all those common to death by apnœa, the special appearances are as follows: The body may be stiffened in almost any position, according to the attitude in death; the tongue is often protruded or pressed against the teeth; the pupils are nearly always dilated, the eyes often staring; the position of the head varies with the part of the neck where the rope or ligature is attached, and the position of the knot; the

commonest position is with the head forcibly flexed forwards, the chin pressing against the upper part of the chest; sometimes it is in the same position as in a man walking with head erect, sometimes bent a little to one side or the other; more rarely the head is completely bent backwards in case the knot was just under the chin. In fact, as Tardieu says, the head will always be found inclined to the opposite side, so that where the cord which suspends it forms the knot, which answers to its fixed attachment, and towards the side, as the middle of the loop thus formed for the neck; hence, as the middle of the loop is nearly always in front, the head bends towards the chest; the hands vary in positions like the head, and the fists are often closed, and so tightly, that the finger nails often penetrate the palms; but in incomplete hanging the hands may be stretched out, or rest on the ground, open, and rarely one or more may be found fixed in the endeavor to loosen the rope; the legs also vary in position, but they are generally somewhat livid; the face is sometimes pale, more often congested, especially in those who have been long suspended; it is generally admitted that there is often froth stained with blood about the nose and lips; the neck is streched in nearly all cases owing to the weight of the body; it presents marks varying with the kind of ligature, and its mode of application and the great or less vitality of the tissues.

In addition to ropes, ribbons, cravats, etc., all have been employed; while window sashes. fences, posts or the feet of a bed, etc., have all been used to attach the ligature; the marks of course will vary with the size and stiffness of the ligature, and with the kind of knot or loop formed; it need not go all around the neck to destroy life. The knot may also be in front or behind or at either side; rarely, when the hanging has been brief and the ligature soft and supple, there may be scarcely any mark at all. More often there is a groove or furrow in the neck, which in eighty per cent. will be between the chin and the larynx, or upper part of the windpipe; this may be oblique in direction, and the mark is often interrupted; this furrow is single or double like its cause. A large, thick single-sewed leather thong, pressing only by its border, would leave a double mark, and the furrow may not quite correspond with the size of the ligature in general; the narrower the cord or ligature, and the longer the hanging, the deeper the furrow. In cases of short suspension the color may

be quite natural; so also when the blood vessels and skin are young and healthy; more often, indeed, sometimes after only short suspension, the furrow undergoes a sort of desiccation and becomes like parchment; above and below the borders of the furrow, which are slightly raised in most cases; the skin is generally violet, a color usually due to congestion. There may also be finger marks, even in cases of suicide; note their direction, size and number; if the furrow be cut into, sometimes blood escapes; the state of the genital organs is often one of turgescence, so that in males the penis is more or less erect or large, and there is an emission of something like seminal fluid, which is really prostatic in most cases, and may be mixed with blood; in the female there may be an erect clitoris, and there is often a sort of spurious menstruation. There is, however, no reason to believe that any pleasurable feelings are connected with this. (See Boismont and Tardieu.)

HANGING, OR SUSPENSION AFTER DEATH.

Casper found in his experiments that if a body were hanged immediately after death (say within one or two hours) the appearances as to the mark of the cord, etc., were just the same as if death had taken place by hanging; in one place seventy two hours had elapsed. These remarks apply exclusively to the outside of the body, and to the neck in particular. Casper's conclusions are somewhat contradictory as regards his own experiments at different times; but Taylor and others adopt his conclusions in the main, as we are also bound to do; so far as that of the tissues preserve a certain amount of vitality, the cord will produce marks; the blood, however, will be less fluid, and there would not be extravasation of blood.

Your answer to the question, was death caused by hanging? can seldom be positive as regards the medical evidence alone, since we have seen, that there is no one sign peculiar to hanging constantly met with. The second question, was death suicidal or homicidal? depends on a variety of circumstances, and like the former can seldom, if ever, be answered from post mortem appearances.

You must carefully note down the surroundings, the absence of all signs of struggling and marks of injury on the body, as well as the previous history of the defunct; the time, place and manner of the hanging will aid you, if guided by common sense,

to frame your answer. So also where there are other marks of violence on the body, or the furniture of the room, or other surroundings show traces of severe struggling. If both doors and windows are found fastened from the inside, suicide would generally be probable; but this fact is scarcely material evidence. Still a trained observer, such as an undertaker is supposed to be, is wrong to overlook these things, and leave them to the police to discover. Remember that poison may have been given before hand, and the body hanged afterwards to arrest suspicion.

DEATH BY STRANGULATION.

By this, as distinct from hanging or suspension, we mean death by pressure applied either by a ligature around the neck, or by direct pressure of the hands, or otherwise, upon the windpipe, or other parts of the neck.

Tardieu and Taylor justly insist on the greater force required (in adults, at least, and in infants,) to strangulate, than to hang. As therefore, hanging, (except in the case of executions, or of the bodies hanged post mortem) for the most part means *suicide.* So strangulation, accidents excepted, for the most part means *murder.* What we mean by accident may be here illustrated: Dr. Taylor saw in Guy's Hospital, in November, 1874, a boy aged fourteen years, whose silk necktie, knotted and tightly twisted around his neck, was caught in the band of an engine, and his neck drawn down against one of the revolving shafts; the neck was twelve inches in circumference; while the inner circumference of the necktie which compressed the neck was reduced to eight inches. He became black in the face, and blood escaped from his mouth and ears; for six or seven minutes after the ligature was removed he remained insensible; he then revived and was able to speak, but could not hold up his head. When brought to the Hospital soon afterwards, he was sensible; his face was pale, lips were livid, eyes suffused, and the conjunctival injected; he breathed without difficulty, and only complained of a pain when he moved his head. The boy told Dr. Taylor, that, at the time of the accident he felt no pain; he had a sense of choking, and then became insensible; for at least one minute no air entered his lungs. He revived, and left the hospital in about eighteen days. Thus his neck had been compressed for about one minute, and there was a deep circular depression three-

fourths of an inch wide around it. Dr. Taylor therefore advises of a drawing to be made at once of the position of the body and surrounding objects if possible; this advice applies to all cases of bodies found dead under doubtful circumstances. Although strangulation usually means murder, certain cases of undoubted suicide by this method are known to medical jurists. Wherever marks of fingers alone are present to explain the death, we must suspect murder, for the pressure applied by a would-be suicide, by means of his own fingers, would be relaxed so soon as he or she became insensible. But the methods of partial hanging, in reality amount to strangulation, and determined suicides either tighten the ligature with a stick, or by a cord passed two or three times around the neck and tightened by each hand. Rarely, one foot or both lower extremities have been used to tighten the knots by twisting them in loops; sometimes one tight knot sufficed, or a double knot has been tried. As in the case of hanging, the questions which arise are usually simple, so it is in strangulation. The most probable questions, are:

1.—Was death caused by strangulation, in other words, by the forcible compression of the throat?

2.—Was the strangulation accidental, suicidal or homicidal?

3.—How long since death occurred?

To answer the first question we must inquire into "*The Post-Mortem appearances in death by strangulation.*" In the majority of cases death will be due to apnœa (so called asphyxia.) All the appearances of this mode of death will be present, even more marked than in hanging; the face and extremities will be more livid, (violet or black) blood may issue from the mouth, nostrils or even ears; the eyeballs will generally be prominent or blood shot, and the pupils dilated; the genital organs will generally be turgid, as in hanging, and urine, faeces and semen will, in all liklihood have been discharged; the blood will be very dark and fluid. The principal differences between homicidal strangulation, and hanging will probably be:

1st. That the mark of the rope or ligature, though perhaps less deep than in hanging, is more complete; that is, it is usually circular and goes all around the neck more horizontally than in hanging. There are generally other marks of violence on the neck or on the body. In cases of throttling or of garroting, there will be marks of fingers and thumbs; these, in infants or

very young, or very thin persons, may be confined to the front or sides of the wind-pipe. Do not forget to examine the genital organs and their vicinity especially in females. It is said that when cambric, muslin or cashmere, are used, no marks, or slight marks are seen; the thugs in Persia and India are supposed to operate thus artistically.

HOW THE DIFFERENT CAUSES OF DEATH AFFECT THE APPEARANCE OF THE BODY.

Death from starvation is characterized by distinctive phenomena. The body is extremely emaciated, and, even though death were recent, exhales an acrid and fetid odor; the eyes are red and open, the tongue and throat dry, the stomach and intestines empty, and the gall bladder distended with bile; the blood vessels and internal organs are comparatively destitute of blood. Fodèrè remarks that among the most noteworthy phenomena caused by starvation, are the offensive effluvia exhaled from the sufferers, the fetor of their discharges, and the rapidity with which the body passes in a state of putrescence. Such a condition of things is peculiarly favorable to the reception of fever and other contagious diseases, and they acquire in such cases an intensity and virulence rarely seen under other circumstances.

When life has been destroyed by the inhalation of *noxious vapors*, as, for instance, carbonic acid, and sulphurreted hydrogen gas, the head and face are found to be swollen, the eyes protruded, and the tongue fixed between the teeth. The face, if observed soon after death, may be pale, but generally soon becomes livid, as the blood vessels of the head and lungs, and the right vessels of the heart, are filled with dark fluid blood.

When death has been caused by *drowning*, Dr. Marshall Hall says: "When the body is recovered a few hours after drowning, the skin is pale and cold, presenting sometimes patches of livid discoloration; the expression is placid, the eyes half open, the pupils dilated, the tongue swollen and pressed forward, and the lips and nostrils covered by a mucous froth; the fingers are sometimes found torn and abraded, and the hand grasping gravel

or other substances which have been seized in a convulsive struggle at the bottom. Internally, the body presents few appearances which are characteristic of the mode of death. Of these, the presence of a mucous froth, sometimes stained with blood, and perhaps of a little water in the trachea, and of water in the stomach, are most noteworthy. The water contained in the stomach appears to be swallowed previous to death, as after life is extinct the opposition of the curtains of the œsophagus prevents the entrance of the water into the stomach."

Haller and Petit, both eminent authorities, agree with Capuron in thus describing the external and internal appearances of the body in a person found drowned. A drowned body usually presents general paleness of the skin, yet the face will be discolored if death was preceded by long continued struggling. It is to be remarked that upon exposure of the body to the air, discoloration very rapidly ensues. The eyes may be found half opened, attended by dilatation of the pupils. These signs, as also frothing at the mouth, may proceed from other violent means, but still are strong proofs of drowning. Of the internal appearances of the body, may be mentioned a fullness, in greater or less degree, of the blood vessels of the head, and of the right side of the heart, and the blood of the drowned is generally found fluid. The presence of water, then, in the lungs of drowned persons, in the form of froth, is to be considered as an accidental, and not essential circumstance, although it is one of very constant occurence. If this fluid, therefore, is found in large quantities and not beaten into froth, the inference would be that it had passed in after death. With the respect to the presence of water in the stomach, it has been proved by many authors to be general, and when it is discovered in that organ, and is identical with that in which the body is found, it furnishes a strong indication of submersion during life, being a necessary consequence of the act of deglutition, for it has been proved by Finé, Orfila and Marc that it is never found in bodies plunged in the water after death, and cannot be made to enter the stomach without the assistance of a tube passed into the œsophagus.

In death by *hanging*, when fracture of the cervical vertebrae has not taken place, and life has been destroyed by strangulation, the signs are a livid depressed circle upon the neck, made by the cord; the face is distorted; the eyes are open and pro-

truded; the face, shoulders and chest swollen. If the trachea or wind pipe was alone compressed, the face is pale; but when the veins of the neck were pressed, as by the cord, and the heart continues its action for some time, the blood is propelled into the head and causes suffusion of the face.

When *suffocation* is caused by heavy external pressure, as is the case when a compact mass of human beings are crowded in a narrow space, or struggling to escape through some small opening, death is probably caused by respiration being incomplete and long deferred. The bodies of the dead exhibit peculiar appearances; the face and neck are of a uniform violent tint, spotted with blackish ecchymosis, and in some instances blood and froth ooze from the mouth and nostrils.

It may be interesting to return to the subject of drowning, and to notice the observations of Davergie on the appearance of the body in persons who may have perished by submersion. He found that in general no change takes place on the exterior before the fourth or fifth day, and the cadaverous rigidity continues two, three or even four days after submersion. This is probably owing to the coldness of the medium into which the body is placed. On the fourth or fifth day the skin on the palm of the hands begins to whiten, and this change of color takes place particularly on the ball of the thumb and the fleshy eminence in the palm of the hand near the little finger, and also the lateral surface of the fingers. The rest of the body presents nothing particular. On the sixth or seventh day, the skin at the back of the hand commences to whiten, at the same time the skin of the foot has acquired a similar tinge, the skin of the face is softened and of a more faded white than the rest of the body. On the fifteenth day the face is slightly swollen and red; a greenish spot commences to form on the skin over the middle of the breast bone; the hands and feet, with the exception of the dorsum of the latter are quite white, and the skin of the palm of the hand is wrinkled. After one month the face is reddish-brown, the eye lids and lips are green and swollen, the neck is slightly green, and a spot of about six inches in diameter, brown in color and with a green areola, occupies the middle and upper part of the sternum, whilst the scrotum and genita organs are enormously distended with gas. The skin of the hands and feet are quite white and very much wrinkled, presenting the appearance of having been long

enveloped in a poultice. The nails and hair are still very adherent. At two months the body is covered with slime, the face is enormously swelled and of a brown color; the lips are tumefied and separated so as to expose the teeth; the skin on the abdomen, as well as that of the arms, thighs and legs, are still in a natural state.

This is a most remarkable fact, and establishes a striking difference between the progress of putrefaction in water, and when the body is exposed to the atmosphere; in the latter case, the abdomen being the first part to manifest any change. At this period, the skin has become detached from the hands and feet, and having the nails attached to it, form as it were a glove. The hair begins to fall off, and is easily detached by pulling. At three months, or three months and a half, there is a partial destruction of the scalp, eye lids and nose, to such an extent as to make it difficult to tell the age of the individual. The hands and feet are completely naked of skin. At four months and a half, complete destruction of the scalp and features leave the skull bare, and the body unrecognizable. These changes may proceed more rapidly in very hot weather, or in putrid pools or ponds; more slowly in salt water, in very cold weather, and when the body is closely invested with clothing; but the general order of facts remains the same.

TOXICOLOGY.

Toxicants have been known in all ages, it could not be otherwise, if we consider, that these poisons which naturally present themselves to man, must, in early times even more, than to-day, have punished man for his ignorance or reckless curiosity.

It becomes a part no less obligatory to the embalmer, to receive a thorough knowledge of the within also.

The name of poison is given to all substances which, when taken internally or applied externally on the human body, produce either an alteration in the functions of life, or entirely destroy it. Vicat, and after him Fodéré and Orfila, have divided poisons into four distinct classes.

1st. *Irritating poisons*, which irritate and cause the inflamma-

tion of the parts with which they come in contact, such as mercurial and arsenical preparations, those of antimony, copper, tin, zinc, silver, gold, bismuth and lead, concentrated acids and alkalies, chlorine, sodium, bromine, phosphorus, etc., for the minerals.

Animal poisons of this class are cantharides and all vesicating insects.

Vegetable poisons are hallebore, colcynthia, saphnea, colchicum, etc.

2nd. *The narcotic or stupefying poisons*, chemical and pharmaceutical products, as sulphurous and hydrocianic acids, cherry laurel and bitter almonds water, cyanide-morphia and its salts, etc. Vegetal poisons; opium and its preparations, lactucaria, hashish. These poisons paralyze the functions of the nervous system.

3d. *The narcotic acrid poisons*, which participate of the properties of the first and second class, being both irritating and narcotic, as wine, alcohol, ether, chloroform, carbonic acid, oxyde of carbon, camphor. Vegetable poisons of this class: strychnias and products, tobacco, belladona, stramonium, dignitalis, ergot, hemlock etc.

4th. *The septic or putrefying poisons*, which alter or putrefy the liquid of the animal economy, as sulphuretted hydrogen, putrified matter, the pus of malignant pustules, stings or bites of animals, as serpents, scorpions, spiders, tarantulas and the liquid of rabies.

Poisons are known either by the effects on the living economy or by chemical re-agents.

GENERAL SIGNS OF POISONING.

Poisoning must be rightly suspected whenever the patient complains of a nauseous or fetid odor; of an unpleasant acid, alkaline or acrid savor; of a burning heat in the stomach; whenever the mouth is parched or frothy, with lips, and gums either livid, black, yellow or white, with nausea and frequent vomiting of mucous or bilious matter, white, yellow, blue, green or red, effervescing after expulsion from the stomach, accompanied with constipation or alvine ejections more or less abundant, the pulse becomes frequent weak, irregular; intense thirst; respiration laborious; cold sweat; the emission of urine difficult. We must also notice the alteration of the features, the color of the face either pale, livid or grayish; the loss of vision or hearing; the

state of the eyes; general agitation, and the sudden change in the tone of the voice.

We must not forget here, that among the symptoms above enumerated, there are a certain number which become suddenly apparent, in strangulated hernia, or in the spontaneous perforation of the stomach or the bowels, even in the absence of any toxic substance to which such lesions might be attributable.

GENERAL TREATMENT.

The evacuation of the toxic substances is the first step to be taken in case of poisoning; this measure, which is indispensable immediately after the absorption of the poison, is still exceedingly useful even after several hours of indigestion. To obtain this, administer from one-half to three-fourths of a grain of tartar emetic in a glass of water; this dose to be repeated three or four times at an interval of a few minutes; also give tepid water in large quantity. To render vomiting more prompt and copious mechanical means may be resorted to, such as titillation of the tonsils with a feather; an injection of the bowels with some energetic purgative must also be employed. A short time after the absorption of tartar emetic, the antidote must be administered. This counter poison which must be appropriate to the nature of the poison taken, as for object, either to chemically neutralize or transform the soluble poison into an insoluble compound, thereby nullifying its deleterious properties, or else to envelop the poisonous substance completely, and notable to diminish its fatal effects. Moreover, the antidote must possess the virtues of being perfectly safe, even when taken in large doses, as it must be administered in quantities more considerable than chemically required for a neutralization of the poison, so as to be more certain of the result.

GENERAL ANTIDOTES.

In the generality of cases of poisoning, the specific nature of the poison is at first uncertain. In such an occurrence an antidote adapted to combat the effects of a large number of noxious substances would certainly be found of great assistance. Thereupon the following have been proposed as general antidotes:

The hydrated proto-sulphate of iron, or the hydrated persulphate of the same metal, against metallic poisons, also hydrated protoxide of iron and magnesia, held in suspension in water, against arsenic and the metallic poisons. For septic

poisons, animal charcoal; against the alkaloids in general, the preparations of antimony and opium, we have the decoction of nutgalls, tannin, black coffee, tea, and the decoctions of cinchona, and astringent roots and barks.

We propose here as a general antidote against the metallic and alkaloidic poisons, also against toxic plants a mixture of equal parts of magnesia, hydrated peroxide of iron and animal charcoal.

POISONS OF THE FIRST CLASS.

Poisoning by the concentrated acids.

Symptoms of poisoning by the acids have been given under the name of general signs of poisoning.

Antidotes.—Calcined magnesia in water, soap suds, bicarbonate of soda or of potash, spanish white, wood ashes, or carbonate of lime in water or in milk, sweet oil, the white of eggs beaten in water. If none of these ingredients be at hand, gorge the patient with water.

CARBOLIC ACID.

This acid, so extensively employed to-day in various branches of art and industry, has caused fatal accidents. When in a concentrated form, its application upon the skin for a short time, or its fortuitous or voluntary ingestion, have proved fatal; it is in fact a violent poison. Calvert has recommended as the best antidote next and in conjunction with the stomach pump, the oil of sweet almonds or of olive, mixed with a certain quantity of castor oil. According to Mr. Husemann, the veritable antidote is the saccharate of lime. However it is always preferable to promote vomiting as quick as possible after the ingestion of the poison.

CONCENTRATED ALKALIES AND THEIR SALTS.

Symptoms.—Acrid and caustic savor, ejections from the stomach redden curcuma paper, and turn green the syrup of violets, horrible convulsions.

Antidotes.—Water mixed with one-tenth of vinegar, orange or lemon juice diluted with water, weak solutions of citric or tartaric acid, sweet oil, albuminous water, and a great deal of warm water.

PREPARATIONS OF MERCURY.

Symptoms.—Metallic and acrid taste, burning sensations in the throat, contraction of the inner parts of the mouth, stomach and

intestines, nausea; the ejected substances do not act sensibly on litmus paper, hiccough, pulse quick, small, often unequal, raging thirst, difficulty in passing urine, cramps, cold extremities, complete prostration, alteration of the features, delirium.

Antidotes.—Emetics, albuminous water, hydrosulphuretted mineral waters, electuary of sulphur (equal parts of sublimated sulphur and honey) milk, flour in water, magnesia. Albuminous water is made by beating the white of six eggs in a quart of water. Mr. Devergie prefers the yolk to the white of the egg. According to his authority the yolk of one egg will neutralize one-sixth of a grain of sublimate. A safe antidote and very energetic. is the gluten of Tadei—the composition whereof is as follows: Gluten $4\frac{1}{2}$ pounds, Castile soap 1 pound, Water $1\frac{1}{4}$ gallons. Dissolve the gluten and soap in the water; vaporize the liquor slowly in a shallow vessel; pulverize the residue. Six and one-half drachms of this powder administered in some aqueous vehicle will neutralize the effects of fifteen grains of sublimate.

PREPARATIONS OF ARSENIC.

Arsenious acid is about the only preparation of which we shall speak here, although we do not mean that other arsenical preparations are not deleterious. It is well known that aside of the sulphates of arsenic, which, on account of their lack of solubility, are little dangerous, the artificial sulphate, which contain a large dose of arsenious acid in a state of non-combination, the solubles, arsenites, and arseniates, are almost as energetic poisons as arsenious acid itself. But this preparation not being so well known does not play so important a role in the annals of toxicology.

This destructive action of arsenious acid has been known for a long time. The aqua Nopoli, and the aqua Toffana, celebrated poisons of the middle ages in Italy and France, had for a basis arsenious acid.

The importance of arsenious acid as a toxic, makes it a duty for us to speak for it at more length, and to give more precise details than we have done for others.

WHY IS ARSENIC A POISON?

The question of how arsenical compounds act as poisons has been discussed by Binz and Schulz, as follows: Liebig seems to have been up to the present time, the only author who had advanced any theory as to the poisonous action of arsenic. In the

first edition of his work, that of 1843, on the relation of chemistry to agriculture and physiology, he states his views essentially as follows: Arsenious acid and corrosive sublimate possess in a high degree the power of forming with albumen solid compounds. When these substances are taken internally, the albumen of the living tissues thereby loses the power of undergoing those transformations which are necessary to their existence. In this way the life of important parts is destroyed and the death of the whole being is the result.

Liebig did not afterwards uphold this story, although it is still to be found in some chemical hand-books. It has been abandoned for this reason: That a solution of arsenious acid, or one of its salts, does not form the solid compounds (albuminates) as Liebig at first supposed, while this is undoubtedly the case with corrosive sublimate among others. There is, in fact, no single case known where arsenious acid produces any stronger precipitation of the constituents of the body, than does carbonic acid for example.

This non-existence of an arsenical albuminate is also proven by the fact, that an animal can be poisoned by the introduction of an arsenical solution without the spots where it was introduced, even if it is the extremely sensitive conjunction of the eye, showing anything more than a slight redness. In the interior of the body, on the other hand, the changes are very clearly seen. The stomach is the central point of all these, even in cases where no trace of the poison has come in direct contact with it. Anatomical investigations show us that those very tissues of the body which are especially capable of taking up the oxygen of the blood are the very furnaces of disturbance.

The neutral salts of arsenic acid are just as poisonous as those of the arsenious acid, and some say, more so. Arsenious acid can readily be converted into arsenic acid, and the latter passes still more easily into the former. The latter process is aided by albumen in general; the former only by the *living* albumen of plants and animals.

The experiments were first made outside of the organism with single parts. White of egg and fibrine from warm blooded animals were digested with arsenic acid, at the temperature of the body, and were found to reduce it to arsenious acid; fresh brains do the same.

The tissues of the digestive organs, as well as the liver and the undecomposed protoplasm of plants, not only reduced arsenic acid to arsenious acid, but also *oxydized* arsenious acid to arsenic acid. If the tissues which are able to oxydize the lower to the higher acid are previously heated to boiling water, they lose this property. Blood, haemoglobin and fresh fat, do not possess either one or the other action.

This double property can be proven in living animals. The two different oxides of arsenic acid are converted, the one into the other, by the lining of the intestines, which, in cases of poisoning, belong to those parts which are first and most violently affected. On the other hand, those parts which in life are touched, or only later and secondarily, are not able to start these changes, especially to oxidize arsenious acid.

Careful and accurate consideration of all the details lead to the conclusion that the conversion and reconversion of these acids into one another in the animal body, causes a violent vibration of the oxygen atoms in the molecules of living albumen, whereby the tissues are corroded until totally destroyed.

In this respect there is a perfect parallelism between nitrogen and phosphorus. Nitric oxide is excessively poisonous. By taking up oxygen, it is converted into violently oxidizing hyponitric acid. It destroys the tissues, while it is in part reconverted with absorption of water into nitric oxide. In the whole reaction the nitrogen takes no direct part. It is merely the inert carrier and distributer of the powerfully aggressive active oxygen atom. Arsenic plays the same role here, where it appears as the carrier of active oxygen; that is, it is every instant passing from arsenious acid to arsenic acid and back again to the former acid.

The distinctions between arsenic and nitrogen are only gradual. The oxides of nitrogen attack the parts where they enter the organism; the oxides of arsenic at first develop their activity within themselves, and it is only by long activity that they are recognized as corrosive without. The active oxygen of nitric oxide instantly tears itself loose, but that of arsenic acid requires some time, and that is the reason why the latter first shows its destructive effects within the organism. That such oxygen atoms possess poisonous properties is evident from the well known poisonous action of *ozone* when it passes into the organ-

ism, except in an exceedingly dilute form. This has recently been shown, too, in the case of chlorates. They give up their three atoms of oxygen to certain constituents of the body, being reduced to chlorides, and thereby act corrosive and destructive to the cells and the blood.

The other members of the nitrogen group show a remarkable coincidence, both in their chemical and poisonous properties. Antimony, bismuth and vanadium pass rapidly from one degree of oxidation to another. Phosphorus generates ozone in the body as well as in the air, and thus destroys the albumen. The good effects of these as remedies can also be traced to the action of their active oxygen.

Symptoms.—Arsenious acids act in a manner analogous on the animal system. Dr. Baude states: Whatever may be its mode of introduction, whether it be through the digestive organs, or the natural openings, as the vagina or rectum; by absorption through a wound, or again by being injected into the veinous system, in all cases it has for effect to augment the secretions, it brings on convulsions, it completely destroys irritability, and finally produces death.

The similitude of results conclusively demonstates that this poison only acts after absorption, and these effects are the more prompt as the poison is more rapidly carried into the circulation; and the injection into the veins, or the absorption into a wound, produces effects more subtile and rapid than when introduced into the stomach or absorbed by other mucous surfaces. It has happened that larger doses of this acid have been taken without causing any derangement of the vital functions for several hours afterward, whilst at other times the effects were very rapid. Thus we see the results may be modified according to the form under which the poison has been administered. For instance, it is easily understood that the vitreous acid being more soluble than the opaque will act more rapidly, and that if the poison is soluble in the substance which serves it, as a vehicle, the effect will still be more prompt, as everything else being equal, the absorption will be more easy.

Symptoms.—Nausea, and ejection of mucous matter mixed with blood. Vomiting does not generally take place until several hours after the injection of the poison, and then successively appear precursive anxiety, burning pains in the region of the

stomach; colic, followed by alvine stools; great thirst, with a feeling of constriction of the oesophagus; drinks of the most emollient sorts are rejected; the pulse is full and frequent; the heart beats strongly; the face and the body prespire freely; breeding is impeded; the face assumes a congested appearance; and eruption, accompanied with a sensation of pricking, resembling that of nettles, covers the body; often convulsions with intense pains drive the patient to despair; at last complete prostration takes place, followed by an apparent calmness; a cold sweat covers the body; the pulsations of the heart become slower and irregular, and death finds the patient in a state of complete prostration.

Antidotes.—Promote vomiting, and at the same time administer the hydrated gelatinous peroxide of iron in large doses—in fact gorge the patient with it, three or four pounds if necessary; mix it in sweetened water. If the gelatinous oxide is not to be obtained immediately, use the peroxide dry, as commonly found in the shops, and mix with sweetened water.

Messrs. Bouchardat and Sandrans propose also hydrated magnesia. If the above substances cannot be readily had, administer pure lime water, mixed with oil or milk, or powdered charcoal in sweetened water; mucilaginous drinks, potions of sweet almond oil or olive oil; albuminous or sulphurous water, even well water from a calcareous soil.

The hydrated peroxide of iron was presented in 1834 by Dr. Bunsen as an antidote against arsenious acid; and it can be safely asserted that according to numerous experiments on the human or animal species, it has proved one of the best and most energetic counter poisons, provided, however, it is administered before the absorption of the poison in the systen. Its action is altogether a chemical one; it forms with the arsenious acid an arsenite of iron, which being insoluble has no longer any effects upon the human organism. It has been estimated that seven and one-half drachms of dry hydrated peroxide of iron will neutralize one and one half grains of arsenious acid.

Magnesia, which was at first proposed in 1795 by Mr. Maudel, remained in oblivion until 1846, when Mr. Bussy demonstrated that its properties as an antidote of arsenious acid were far superior to those of the peroxide of iron. First, because it is more easily procured than the peroxide. Second, because its laxative

properties produce more rapidly the expulsion of the poison. Magnesia must be administered in excess, stirred in water, and must be but slightly calcined.

Mr. Blondlot, after varied and numerous experiments with fatty substances, as oil, butter and milk, as antidotes of arsenious acid, was led to the conclusion that in certain cases they might be used as counter poisons of this acid by retarding its dissolution, hence its absorption.

In poisoning by the preparations of copper, bismuth, tin, zinc, iron, silver and gold, the symptoms are similar to those of the mercurial preparations, and the antidotes are the same.

PREPARATIONS OF LEAD.

Symptoms.—(Taste) sweet, astringent, metallic, very disagreeable; contraction of the throat.

Antidotes.—Solutions of sulphate of soda, or of magnesia; albuminous water; lemonade, either tartaric or sulphuric magnesia.

CHLORINE, IODINE, BROMINE.

Symptoms.—Intense contraction in the breast, especially if caused by chlorine, suffocation, bloody expectorations. If caused by iodine or bromine, nausea; parched throat; vomiting of yellowish substances with an odor of bromine or iodine.

Antidotes.—*For chlorine*, ammoniated water; magnesia; albuminous water. *For iodine* or *bromine*, starch, milk, albumine. Poisoning by bromine could be treated by the iodide of sodium, and iodine by the bromide of sodium.

NARCOTIC POISONS—SECOND CLASS.

These poisons comprise aniline, codein, morphia, opium, laudanum, bitter almonds, cyanide of potassium, hydrocianic, cyanhydric or prussic acid. All of the above are narcotic poisons in their effects.

Symptoms.—Stupor; feeling of heaviness in the head, tendency to sleep; haggard looks; pupils of the eye either contracted or distended, sometimes almost natural; delirium, either furious or excessive joy; hallucinations; pains and convulsions in certain parts of the body; paralysis of the legs; pulse variable; vomiting, especially when the poison has been applied on some part of the body deprived of the cuticle.

Treatment.—Excite vomiting; this result being obtained, give acidulated drinks; give a decoction of coffee against narcotism;

frictions on all parts of the body are useful; also bleeding in the arm or the jugular. If the patient is struck with apoplexy, the same course must be followed if the poison has been applied internally, but in that case vomiting must not be checked. Mr. Bussy advises in this case the use of magnesia. We must add here also that all mineral alkalies as well as charcoal are useful.

In cases of poisoning by prussic acid excite vomiting; the chlorine water for aspirations; ammoniated water; applications of ice water on the head, back of the neck, and all along the the spinal column; leeches behind the ears; bleeding of the arm or jugular; rub the temples with tincture of cantharides and ammonia, mustard plasters at the feet. Unhappily none of these means are certain, as the lightning-like action of the poison, particularly on warm blooded animals, is especially due to its mechanical action in stopping almost suddenly the oxydation of the blood. It was stated that the salts of iron might be efficacious as an antidote of prussic acid; there exists no longer any doubt about it. The salts of iron are generally administered in the following formula: Ten grains sulphate of iron dissolved in six ounces of sweetened water, to be taken simultaneously with three and one-half drachms of carbonate of soda in solution.

The antidote generally adopted for the cyanide or cyanuret of potassium, is the sesquioxide of iron. Prussic acid and the cyanide of potash disappear completely in the body by the process of putrefaction.

EFFECTS OF THE POISONS OF THE THIRD CLASS.

Symptoms.—Excitation of the brain and the spinal marrow; general and convulsive stiffness; head thrown back; difficult breathing; abdominal pains; tendency to vomit, inclination to sleep; eminent danger of asphyxia.

Antidotes.—Excite vomiting; purgatives; bleeding; iodine water; tannin; infusion of nutgalls; tea; coffee; magnesia; charcoal, or general antidotes.

This class includes the following poisons: strychnia, brucine—which, when administered repeatedly in infinite small doses, produces all the symptoms of an exhaustive and lingering sickness until death ensues, and which scarcely leaves any traces—digitaline and chloroform.

POISONS OF THE FOURTH CLASS.

Including snake bites, introduction of *septic poisons* into the system by cuts or punctures of the scalpel in the dissecting room, sores, cuts, bruises on the hands, and abrasion of the skin.

External Treatment.—Make a firm ligature, not too tight, immediately above the wound; compress the parts surrounding to assist bleeding and the ejection of the virus; cauterize either with a hot iron, lunar caustic, chloride of antimony, chloride of zinc, or nitric acid; concentrated sulphuric acid, liquor ammonia, or the following solution: Iodine, 18 grains; Iodide of Potash, 1 drachm; Water, 2 ounces.

Internal Treatment.—Calming and sudorific potions, subcutaneous injections of ammonia. Dr. Dusourd speaks of numerous cures effected by the use internally and externally of olive oil.

Bites and Stings of Insects.—If the symptoms are light, rub on the wound tincture of iron, volatile liniment, or a few drops of ammonia in one or two teaspoonsful of cologne water. During the heat of the summer, and if the symptoms are alarming, if the insect is likely to have fed on venomous plants, or putrefying bodies, or on carrion, and if there is danger of a malignant postule; cauterize the wound as above, after extracting from the wound the sting which might have remained behind; apply also liquid carbolic acid on the wound.

ABSORPTION OF POISONS.

As a general rule, whatever may be the surface or texture to which a poison is applied, it is absorbed and circulated with the blood before it begins to manifest its effects. Liquid poisons when swallowed are more rapidly absorbed than those which are solid. Soluble poisons, such as the cyanide of potassium, are absorbed more rapidly than those which are insoluble, and the larger the quantity of fluid in which the poison is taken, the more rapidly it is carried into the circulation. Some solid substances which are little soluble (arsenious acid) are, however, very soon absorbed in sufficient proportion to produce well-marked symptoms. Others which are not very soluble in water may become dissolved in the acid secretions of the stomach and are then absorbed. The carbonate of lead, and the arsenite of copper, furnish us with instances of this action.

Absorption varies in its action and rapidity, not only according to the state of the poison, but according to the nature of the surface to which it is applied. It takes place slowly through the unbroken skin; nevertheless, symptoms of incipient narcotism have been known to arise during the application of an opiate liniment to the back. Belladona, creosote, prussic acid, morphia, and numerous other agents, have a well known action by absorption through the skin.

The frequent handling of pewter and lead has been known to give rise to symptoms of poisoning by lead, and the effects of mercurial poisoning may be produced by the application of mercury in a finely divided state to the skin.

When the cuticle is removed and the surface of the true skin is laid bare, then the absorption of poision takes place with much greater rapidity. Any ulcer or wound is a ready medium for the absorption of poison. Arsenic, as well as all mineral and vegetable poisons, may thus give rise to a train of symptoms similar to those caused by the introduction of the poison into the stomach and bowels, and the applications of quack preparations containing these poisons to scirrhous ulcers, has, in several instances, caused death with the usual symptoms. Sometimes the substance itself acts chemically upon the skin, removes the cuticle, and thus leads to complete absorption.

Absorption occurs with great rapidity when the poison is introduced into the cellular tissues beneath the skin, and small quantities have been known to produce powerful effects. Thus Orfila found that from half a grain to a grain of arsenic in powder was sufficient to kill a dog under these circumstances. This mode of poisoning is generally confined in a human subject. To those cases which arise from the bite of rabid animals or venomous serpents, or in which by accident *noxious animal matter is introduced into a wound*, the general conclusion from these experiments is that but a small quantity of poison is required to destroy life, and that the effects of poisons are more rapidly manifested when they are brought into direct contact with the cellular membrane, than under any other circumstances.

Some poisons—the woovara and the poison of serpents (echidine,) which are readily absorbed through a wound, appear to resist the absorbing action of the stomach. Dr. Spooner states, that he has administered the poison of glanders through the

mouth without any injury whatever, but the point of a lancet charged with this virus and inserted into the flesh, is sufficient to propagate the disorder in all its virulence.

The mucous membrane of the lungs, by reason of its thinness, its great extent and the absence of protecting epitherial surface in the air cells, is well adapted for absorbing aerial poisons, and at once conveying them into the blood. The action of the poisonous gases, sulphuretted hydrogen and carbonic acid, furnish instances of the rapidity with which poisons produce their effect through the lungs. It is through this medium that poisonous miasmata and the poisons of contagious diseases are received into the body.

IODIDE OF STARCH IN POISONING.

As a general antidote in poisoning, Dr. Bellini, in a paper read before the Medical Society of Florence, Italy, recommends iodide of starch. It is free from any disagreeable taste, and does not possess the irritating properties of iodine, so that it can be administered in large doses. He has made numerous experiments, and states as a result of these, that at a temperature of the stomach, and in the presence of the gastric juice, the iodine combines with many of the poisons, forming in some cases insoluble compounds, in others soluble compounds, which are harmless so long as they do not exist in too large quantities. He recommends it as safe in cases where the nature of the poison is unknown, and as especially efficient in cases of poisoning by the alkaloids and alkaline sulphides, by ammonia, and especially by those alkaloids with which iodine forms insoluble compounds. In cases of poisoning by salts of lead and mercury, it aids the elimination of these compounds. In cases of acute poisoning, an emetic should be employed soon after the administration.

ZYMOTIC CONTAGION.

Professor Lyndall asserts that diseases are propagated not by effluvia or sewer gas, but by solid particles discharged into the atmosphere by currents of air and gas. This he proved by the following experiment: He cut up a piece of steak, steeped in water, heated it, at a little above the temperature of the blood, then strained off the liquor; in a short time, this fluid became turbid, and when examined through the microscope was found to be swarming with living organism; by the application of heat these were killed, and when the solution was filtered he obtained

a perfectly pure liquid, which, if kept free from particles of dust, would remain pure for an unlimited period of time, but if a fly were to dip its leg in fluid containing living organism and then into the pure liquid, the whole would be swarming with animalculae in forty-eight hours.

BACTERIA IN THE AIR.

By a certain process M. Miquel has succeeded in seizing and numbering the spores or eggs of bacteria, and, while confirming M. Pasteur's observations that they are always present in the air, shows that their number presents incessant variations. Very small in winter, it increases in spring, is very high in summer and autumn, then sinks rapidly when frosts set in. This law also applies to spores of champignons; but while the spores of moulds are abundant in wet periods, the number of aerial bacteria becomes very small, and it only rises again when drouth prevades the soil, a time when the spores or moulds become rare. Thus, to the *maxima* of moulds correspond the *minima* of bacteria, and reciprocally. In summer and autumn, at Montsouris, one finds frequently one thousand germs of bacteria in a cubic metre of air. In winter the number not uncommonly descends to four or five, and on some days the dust from two hundred liters of air proves incapable of causing infection of liquors the most alterable. In the interior of houses, and in absence of mechanical movements raising dust from the surface of objects, the air becomes fertilizing only in volume of thirty to fifty liters. In M. Miquel's laboratory, the dust of five liters usually serves to effect the alteration of neutral bouillon. In the Paris sewers, infection of the same liquor is produced by particles in one liter of the air.

These results differ considerably, it is pointed out, from those published by Tyndall, who says, a few cubic centimetres of air will, in most cases, bring infection into the most diverse infusions. M. Miquel compared the number of deaths from contagious and epidemic diseases in Paris with the number of bacteria in the air during the period from December, 1879, to June, 1880, and, certainly, each recradesence of aerial bacteria was followed at about eight days interval by an increase of the deaths in question. Unwilling to say positively that this is more than a mere coincidence, he projects further observations regarding it. M. Miquel further finds (contrary to some authors) that the water

vapor which rises from the ground, from rivers, from masses in full putrefaction, is always micrographically pure, that gases from buried matter in course of decomposition are always exempt from bacteria, and that even impure air sent through putrefied meat, far from being charged with microbes, is entirely purefied, provided only the putrid filter be in a state of moisture comparable to that of earth at 0.30 metre from the surface of the ground.

POST MORTEM EXAMINATIONS.

Before commencing the work of embalming, and even while laying out a corpse, it is always necessary to make an inspection of the surface of the body. The minuteness of the inspection will depend upon the character of the case, and in a great measure, dictate the course of treatment to be followed so as to insure success. It also behooves the operator, for his own safety, to look for evidences of skin diseases, ulcers, abscesses etc.; the glands, penis and prepuce are to be carefully examined for syphilitic cicatrices.

It is customary to find certain changes in the external appearance of the body, which are due to the cessation of vitality in the tissues and the commencement of decomposition. I speak now of bodies which have not yet been buried, and which have been kept in the ordinary way partly covered, and lying on the back on the bed or cooling board. If the bodies have been left in their ordinary clothes, the appearances are just the same. In such bodies, one of the first noticeable changes, is the paleness of the skin and its mottling with irregular livid patches. After a short time the blood settles in the vessels of the more dependent portions of the body, and the skin which covers the back of the trunk and extremities becomes of a livid color.

In many cases if we cut through the skin, we find the tissues beneath congested and infiltrated with bloody scum; in bodies which have been kept for a number of days in cold weather, this red color is also seen on the anterior portions of the body, especially on the face and neck. In hot weather, the red color is very soon altered by decomposition; if the epidermis has been

detached at any point, the skin beneath this is dry, hard and red. In warm weather, we may find, a few hours after death, broad bluish lines, corresponding to the cutaneous veins, ramifying in the skin of the neck and thorax. These lines are formed by the escape of the coloring matter of the blood from the vessels.

Within a few hours after death, even in cold weather, there is usually some escape of bloody froth and mucous from the mouth and nose. If the eyelids are not closed, the cornea soon become dry, brown and hard, the eyeballs also become flaccid. After a considerable time the skin of the abdomen becomes green; still later, decomposition fairly sets in. The entire body is of a dark green color; the tissues are infiltrated with serum, the abdomen is distended with gas, then the color changes from a green to a reddish brown; the epidermis is detached; the skin is covered with maggots; the entire body is swollen from the formation of gases; the face can hardly be recognized; the nails drop off, and the scalp becomes detached.

When a body is in this condition it can hardly be determined whether a month or five months have elapsed since death occured. After this, all the soft parts change into a formless, pustulent mass. The cavities are open, the viscera is indistinguishable, and the bones are left bare.

The rapidity with which these changes take place, vary under the influence of a great number of conditions. The bodies of infants usually decompose more rapidly than those of adults; fat bodies putrefy quicker than lean ones; the bodies of persons who die suddenly from violence, decompose less rapidly than the average, unless the body be considerably mangled. Exhausting diseases, fevers, and the puerperal condition, are followed by rapid decomposition, as is also death from suffocating gases. Poisoning by alcohol, arsenic and by sulphuric acid, may preserve the bodies for an unusual length of time. Atmospheric air, moisture and warmth quicken decomposition. At the same temperature, a body which has been for one week in the air, one which has been two weeks in the water, and one which has been eight weeks buried in the usual way, will all exhibit the same degree of decomposition.

That too much care cannot be used in handling the bodies of persons who have died of certain diseases, especially when their bodies are to be subjected to the embalming process, which

operation is rendered extremely dangerous to the embalmer, from the fact that the hands must perforce, come into direct contact with the denuded tissues, the blood, or some vitiated secretion of the body.

This chapter may prove tedious to some, but it is, however, an undeniable fact, that the preceding information (compiled by F. Delafield, M. D., on Morbid Anatomy) is of the utmost importance to the professional undertaker. The external examination of the body, before handling, is a matter not to be neglected. Should any syphilitic sores, or foul ulcers, be present, the utmost caution must be used in handling the body, as the pus, which is a most virulent poison, might find its way into the system through some abraision of the skin. The effects of this poison are such, that, should it not prove fatal, it will leave in the system traces that can never be completely eradicated.

MORBID POISON AND DISINFECTANTS.

By morbid poison we understand a product which is the supposed specific cause of certain specific diseases—of syphilis, for instance; of scarlatina, of typhus, of glanders, of small pox, of hydrophobia, and the like— a product which has many striking differences from all other poisons, but chiefly this: first, that while other poisons (oxalic, or hydrocianic acid, or sulphuretted hydrogen) act directly in proportion to their dose, becoming more or less deadly as more of them are brought to bear on the organism. You may observe, on the contrary, that morbid poison (the poison of contagion) produces its characteristic results, when given in the manifest conceivable doses, just as surely, and just as deadly, as when the system is saturated with it; and secondly, that when poisons diminish from the body, or at the most, remain stationary during the production of their effects, morbid poisons apparently undergo, within the body on which they act, a striking and singular increase.

The phenomena which follow infection with a morbid poison consists of certain local changes, attended by a peculiar constitutional state.

The local changes may be generalized, as sub-acute inflam-

matory processes attended, perhaps preceeded, by the deposition of a specific material, which material in most cases contains an agent capable by inoculation, of producing in another person the same symptoms as have attended its own generation in the original sufferer.

The peculiar constitutional state is one essentially of depression, modified no doubt, and intermixed with those phenomena of reaction, which the living body, like a spring, always opposes to the direct pressure of exterior influences. And now to connect these phenomena with a cause, let us examine what takes place when small pox is inocculated. This will do as an instance of infection.

If you puncture the arm of a healthy person, not previously defended by vaccination or otherwise, with a lancet which has pricked the postule of a person afflicted with small pox, a little dry animal matter may have remained on the point of the lancet, and what then will be the result? On the second day after the operation if the part be viewed through a lense, there appears an orange colored stain about the incission, and the surrounding skin seems contracted. On the following day a minute papular elevation of the skin is perceptible, which on the fourth day is transformed into a vessicle with a depressed center. The patient perceives an itching in the part. On the sixth day some pain and stiffness are felt in the axilla or arm pit, proving the absorption of the virus into the general mass of blood. Occasionally on the seventh, but generally on the eight day, rigors occur, accompanied sometimes with faintishness, sometimes with pains in the back, headache, or vomiting. The patient complains of a disagreeable taste in the mouth, and the breath is offensive, soon after which the eruption shows itself. If the patient be a woman, and pregnant, her foetus will generally have been affected, and if so will have died. Finally, when the eruption has developed itself, you find that any one of these new pustules inherits the infective power of that, from which they were developed; and thus from one patient you can obtain enough morbid poison to diffuse small pox throughout the habitable globe in an inconceivable short space of time. If you observe this immense increase of material, and remember the almost imperceptible stain on the point of the lancet, than you have its material reproduced by a thousand fold—a million fold multipli-

cation. But it is not only by inoculation, i. e. by breach of surface, that the disease can propagate itself to the body of a previous healthy person. As I have already stated, the foetus in utero may contract the disease from its mother; therefore the material cause of the phenomena is soluble; for between the circulating system of mother and child there can be no other communication than by fluid matter. And further, the material is *volatile*, for persons having no contact with the patient either directly or (except for the atmosphere) indirectly, are likewise liable to contract the disease.

Finally, material of the blood in which the virus of small pox effects this peculiar change, seems, through a normal constituent no essential one; for the patient convalescent from small pox though with no demonstrable trace of that constituent in his blood, returns to at least as good health as he enjoyed previously. It may be added, too, that in a certain very small proportion this material ingredient of the blood appears to be not uniformly present, for there are persons (apparently undefended by any previous occurrence of the disease, or by other known means) in whom the original inoculation would have failed—persons who would have shown a nonifectibility by the poison and who therefore must (at least for the time) have been without that material in their blood which constitutes the susceptibility to the disease. The line of argument which I have followed in regard to small pox, leads to very similar, though not identical results in respect of measles, scarlatina, typhus, glander, plague, etc. There is the same evidence that a certain definable state of the blood is one of the conditions for the formation of the disease.

But there is a very common disease which introduces some new difficulties in the theory of disease—I mean syphilis. If you inoculate syphilis, or if by some untoward accident the secretion of a chancre, or bubo, or other syphilitic sore, is inoculated through some abrasion, cut, bruise, or breach of surface, you get, almost certainly, a pustule at the spot, rapidly followed by induration and by a considerable local increase of the poison. For wherever that induration extends, there you have the characteristic infective material of the disease. But presently that induration soften itself, the ulcer which was seated upon it becomes cicatrized, and the patient flatters himself with the conviction of recovery. Six weeks afterwards, more or less, this

conviction begins to be disturbed; some general indisposition attacks the patient—not quite such as I described after the inoculation of smallpox, not so acute or severe—but a feeling of being out of sorts, and a feeling of general feverishness and malaria in the midst of which appears the characteristic of syphilis.

I may take this opportunity of exlpaining to you a difficulty which arises in the doctrine of morbid poisons from considering the mitigation which their severity often appears to undergo, when they are infected by artificial inoculation. It appears that while infection is the certain test and evidence of certain materials in the blood, inoculation is, in many cases, a much finer test, than can be afforded by atmospheric inhalation; and, as the severity of symptoms will be in proportion to that chemical state of the individual by which he is infectible, so I would explain frequent comparative mildness of inoculated small pox.

By inhalation of the volatile virus, fewer would be affected, but those few would have the disease severely. This method of infection, including only those persons who have a great abundance of the material which renders infection possible, and who would naturally suffer much, while the process of inoculation (being, as I expressed it, a finer test) will elicit evidence of the disease for a far larger number of persons, will include many who possess a minimum of the symptom—producing material, and who, for that very reason, will suffer this disease in its mildest form. On the same principle I would explain that other fact, well known in practice, that on the first invasion of an epidemic, the proportion of mortality is greatest; while later in its progress the proportion of recovery is increased.

With respect to that well known deleterious agent which arises in the decomposition of vegetable matters—*the paludal poison*—which is the cause of the milder ague of our climate and the deadly malarious fevers of the tropics. That it is a material poison, capable of effecting entry into the blood, and not any mere physical influence inherent in the soil, seems certain. We can trace its operation in a definite line of progress through space, and can observe it becoming arrested by material impediments, by trees, or by a line of buildings; it is soluble, for it has a difficulty in crossing water—probably from undergoing solution there; heat is its great evolver; watery moisture its chief vehicle. Whether it consist in some complicated

organic product, or is of a simpler constitution, I am not able to decide; but I may here say that the late Dr. Daniell in analyzing the deadly waters of the Gambia, found in them no unnatural quality but one—they contained a considerable quantity of sulphuretted hydrogen.

In intimate, but most obscure relation to those paludal poisons, stands the unknown cause of the so called *Asiatic cholera*, an influence which is migratory, moving in definable line round the globe and affecting large regions in succession, but yet, in its migrations evincing so singular a preference for malarial districts that it might be called epichorial rather than epidemic, and we might not improbably conjecture of its wandering cause, that it consists of some agent capable of determining a secondary modification, in whatever malarious atmosphere it may traverse.

Whether the primary influence be aerial, telluric, or even astral, we are quite ignorant. We only know that in some parts of Asia it is now constant, and that periodically it tends of a while to enlarge the area of its operations, advancing with each year more and more, till its shadow encircles the globe, and then retreating again within its original focus. In its European excursions it has prevailed for three years, returning each autumn in the localities first affected by it, with a severity gradual, both as to its increase and its decline. On its communicability from person to person proof has never yet been given; but of the intensely poisoned condition of the district in which it prevails, innumerable records bear evidence. In all probability the disease spreads independent of any personal intercourse, and the power of infection may be considered an appurtenance of the district rather than a property of the sufferers. The eliminative acts caused by the poison of cholera are among the most violent manifestations of disease, stripping off the epithelium of the intestinal canal, and purging of fluid by stool, and vomit, with a rapidity which literally desiccates and shrivels the patient, so that his blood, by reason of its extreme inspissation, is rendered incapable of its normal functions. There is a degree of its operation however, in which the choleraic poison, like that of yellow fever, may kill and leave no sign. Death may occur from its intensest action, even within a few minutes. "When the cholera reached Muscat (says Dr. Williams) in some instances only ten minutes elapsed from the time of the first seizure until life was extinct; and at

Punderpore, the disease is said to have raged with such severity that 360 persons died in the streets, stumbling over each other lifeless;" or according to another authority, "as if knocked down by lightning." It is useless to say that in such cases no characteristic morbid appearance could be found in the solid organs of the body. And now, to return, to the truly morbid poisons (for I do not include the paludal poison in this phrase, except where I distinctly mention it.) I have spoken with some decision of two conditions as necessary to the infection of disease; first of course, the existence of the poison; secondly, the existence of some other substance, an ingredient of the blood, over which the poison exercises a peculiar influence. I do not consider this statement to embody any particular theory. I consider it to be the simplest generalization of facts which lie within the sphere of our daily observations, partly by reason of the regenerative power of the poison, and partly to overcome difficulties which arise in the question from considering the migration of epidemic diseases. Dr. Holland and Professor Henle have argued, that perhaps the essence of a morbid poison might be a living thing; that the poison might be contagium animatum; that epidemic fevers and their allied disorders, might be consequences of a parasitic developement in the body. Thus would be explained, thought these writers, the latency of diseases after infection, the spread of epidemics and the reproduction of the poison within an infected organism. But this theory can hardly be accepted as an explanation of the fact, as parasitic diseases from first to last, are perhaps from all known maladies the most essentialy local.

From these remarks on the general nature of the infective process, we notice that the surfaces and organs most prone to affection by the diseases under consideration are those which are eliminating and defecating; those, whose normal products can hardly be retained for any time within the body, much less without undergoing a fetid decomposition, which sufficiently stamps them with an excrementatious character; and the bowels, skin, kidneys, and tonsils, are the favorite resorts of the several morbid poisons, just as they are the surfaces by which naturally the organic waste of the several tissues is eliminated. And it is especially under such circumstances—where ventilation is defective, where human beings are unduly crowded, where the air is loaded with putrid or deoxidising influences—that contagious

diseases tend to affect the system, either through a new generation of their poison, or through some vast increase of susceptibility thus engendered. In examining the habitations of the poorest classes in our large cities, we find the atmosphere highly animalized, often fetid with organic matters; the air is so little changed that it stinks with the volatile excretions of the many human beings crowded together, and to these contaminations are very generally added the products of decomposition from their own excretions which lie in cesspools, or have soaked into the soil beneath and around their dwellings. Such an atmosphere can do but little in purifying the blood wherewith itself is already so loaded, and the inhabitants of such localities are consequently maintained artificially replete with those humoral products, which constitute the predisposition to zymotic blood diseases.

THE EFFECTS OF IMPURE AIR.

Ochlectic Poison; The spread of contagious and infectious Diseases. Some of the effects of impure air have been considered in Toxicology, under the head of Poisonous Gases. There are subtle animal poisons, some of which are only recognizable by their effects, probably compound ammonias and cyanogen compounds, which tend to generate and spread diseases. The term ochlectic has been invented as a general term for these. The massing of numbers of people together, also tends to the spreading of other zymotic diseases, such as scarlet fever, measles, small pox, etc. All these subjects are treated of, in manuals of hygiene. You may however be asked: How is the contagion or infection propagated? and how long does the contagion or infection last?

In answer to the *former*, you must reply, that for most of the so called zymotic diseases, there are several ways, in which the disease is spread from person to person, as for example: By direct personal contact with the body, living or dead, of one already diseased; also by contact with the *excreta* of the sick, including particles of the epidermis or cuticle, particles of moist or dry matter (pus) scabs or crusts; portions of coughed up or expectorated matter; the nasal secretion; vomited matter, contact with the urine and faeces; with other fluids and secretions; blood, saliva, prespiration; by soiled clothes, bedding and books used by the sick; by the presence of the air of the sick rooms, and even of infected towns, of famites or other media of conta-

gion; by food and beverages, as by water previously contaminated in any of the ways above mentioned.

Your reply to the second question must be cautiously worded. Unless clothing has been subjected to a dry heat 212° to 300° F., or more, or thoroughly washed with disinfectants and then dried, or exposed to chlorine or sulphurous acid gas; and unless rooms have been treated with the same gaseous disinfectants, or thoroughly cleansed with hot water and soap and exposed for some days to free currents of air, infection will linger lovingly in some of the folds of the clothing, or in the dust of the apartments.

As regards patients, you must be still more cautious. The stools of patients convalescing from cuteric fever appear to be capable of spreading the disease for two or three months (if not disinfected.) A scarlet fever or measles patient will spread the fever until his or her skin has *completely* ceased desquamating; a varilous patient, at least until every particle of scab has been removed from the skin. *Peroxide of hydrogen* or *ozonic of ether* is said by Dr. Gay to check this tendency of scarlet fever or small pox to spread from person to person. He used it in the form of an *ointment* (rubbed up with lard.) *Sulphurous oxide, carbonic acid, chlorine, chloride of lime, bi-chromate of potash, sulphate of copper, sulphate of zinc, chloride of zinc, bi chloride of mercury, sulphate of iron, arsenious acid and arsenate* of soda are the *best known disinfectants.*

HOW TO USE DISINFECTANTS.

First: In the sick room.—The most available agents are fresh air and cleanliness. The clothing, towels, bed linen, etc., should on removal from a patient, and before they are taken from the room, be placed in a pail containing *zinc solution, boiling hot,* if possible. All discharges should be received in vessels containing the *copperas solution.*

Second: Fumigation with sulphur is the only practical method for disinfecting the house; the rooms to be disinfected must be vacated. Heavy clothing, blankets, bedding, etc., which can not be treated with zinc solution should be opened and exposed during fumigation as directed herewith. Close the room as tightly as possible, place the sulphur in iron pans supported upon bricks placed in wash tubs containing a little water. Set it on fire by hot coals, or with the aid of a spoonful of alcohol, and allow the room to remain closed for twenty-four hours. For

a room about ten feet square, at least two pounds of sulphur should be used and in proportion, according to size of room.

Third: *Corpses* should be thoroughly washed with the zinc solution of *double strength;* they should then be wrapped tight in a sheet wet with the zinc solution placed in an air tight casket, and not thereafter exposed under any circumstances. Use *roll sulphur* (brimstone) for fumigation; *sulphate of iron* (copperas) dissolved in water in the proportion of *one and a half pounds* to *the gallon*, this is called (copperas solution).—*Sulphate of zinc and common salt*, dissolved together in water, in the proportion of *four ounces of sulphate of zinc* to *two ounces* of salt, in a *gallon* of water; this is the zinc solution *single strength.*

CONTAGION BY CONTACT; OR, GLANDULAR THEORY OF INFECTION.

In order to make our readers fully acquainted with the dangers arising from carelessness in the handling of bodies, we can not do better than to reproduce the theory adopted by Dr. B. W. Richardson; and with exaggerating these dangers, this may explain the causes of the many insidious disorders which, although not always fatal, prove at times, a burden of suffering to the patient. Some few years ago Dr. Richardson made the discovery that the fluids secreted during the various stages of some forms of communicable disease, or the morbid secretions of persons who have died from the same, could not be made to propagate disease. This he practically proved by producing hospital fever in an animal, by introducing into a wound, previously made, the secretion of a wound from a person who had died from surgical injury. Subsequently the secretions from that animal transmitted the disease to another, and it was thus propagated through four generations. Dr. Richardson then essayed to isolate the poisonous matter, and succeeded in producing a darkish, somewhat powdery, half glistening mass, closely resembling that obtained by drying the fluid which exuded from the cut poison sac of any venomous snake. To this substance he gave the name *septine*, and classified diseases produced by it, as septinous diseases; and in searching for a theory to account for the phenomena

observed, he came to the conclusion that the secretions of the animal body are the sources of the septinous diseases, and that the latter are all of glandular origin; that in every case of disease, the poison producing it, is nothing less, than a modified form of the salivary gastric, or some other secretions. The diseases so produced are small pox, measles, scarlet fever, diptheria, typhus, yellow, hospital, and typhoid fevers, erysipelas, cholera, glanders, boils, carbuncles, and infectious ophthalmia.

Dr. Richardson's other chief conclusions may be briefly summed up as follows: So long as a person is affected with these organic poisons, and is giving off a vapor when living, at a certain temperature, or, if recently dead is still covered with the prespiration of death, *he is poisonous.* The poison is mechanically carried and distributed by the vapor, or by direct contact with the prespiratory moisture of the dead body, or other morbid secretions. These poisons are harmless in the dry state, but resume their activity in water. They may all be destroyed by extreme dilution, by heat, by exposure to moist oxygen, chlorine, iodine, bromine, sulphurous acid, and nitrous acid in a less degree. Bright sunlight is a potent means of their destruction. They are preserved by cold, sulphur, creasote and arsenic, so that they keep their active properties. They do not multiply like germs, but each particle possesses the property of converting certain secretions of the living animal into itself. The poison may travel as dry, solid matter, in sewage, or be wafted through the air, or in linen saturated with secretions, or may exist in vapor, or in watery vapor.

It is stated that the nnmber of closely communicable diseases is intimately related to the number of secretions. The poison of hydrophobia is from salivary secretions; of dyptheria, from the mucous glands of the throat; of scarlet fever, from the lymphatic glandular secretions; of glands, from the mucous secretions of the nasal surface; of typhoid fever, from the mucous glands of the intestinal surface and so on. In many instances the blood itself is infected, and the corpuscular matter, becomes the seat of a catalytic change.

Dr. Richardson also advances the views that an extreme nervous impression (such as is the case where a prevailing disease can only be traced to fear or anxiety,) acts on the glandular nervous supply, paralyzes the glandular functions, and thereupon

produces the same phenomena as is produced in other instances by the action of a specific poison. These poisons act first on the nervous fiber, and the irritation caused, gradually extends to the nervous center. That is what slowly takes place in hydrophobia.

Another conclusion is, that the communicable diseases are hereditary; and still another sequence of Dr. Richardson's researches. leads to the explanation of non-recurrence of the disease, after they have once attacked a person susceptible to them. They who are susceptible, are born with a nervous impression tending to the production of a glandular secretion, easily changed into poisonous secretion under the direct action of contact with poisonous matter. or even under the influence of a central nervous derangement, whereby the glandular function is deranged. Dr. Richardson considered that if this theory be true, we have complete mastery over the diffusion of the poisons of all communicable diseases.

The body of a man, or animal affected with a contagious disease, is as deadly as the cobra, and he should be isolated, and care be taken that its secretions; volatile, solid or fluid, while living or after death, do not come in contact with the secretions of susceptible healthy persons (as, for instance, the secretion of the mucous glands of the throat of a person, who has died of diphtheria coming into contact with the excoriated surface, cuts etc., on the hands of a healthy person, or even where the skin is entire, it may be absorbed, if allowed to remain for some time, especially if the hands are in a state of perspiration;) thus the danger can be avoided.

Finally, this theory suggests to those who are engaged in handling the remains of persons who may have died of some communicable disease, the best means of arresting its progress, even when the phenomena of it have developed to some extent, by seeking for remedies among chemical agents which affect special secretions; and it shows how to place the sick under such conditions, that the absorption, of their own poisonous secretions —that deep absorption, which is the actual cause of death in the great majority of cases of contagious diseases—may be avoided.

DANGERS ARISING FROM HANDLING THE DEAD.

To those who, like physicians, students and nurses, are almost constantly thrown into direct contact with every form of epidemic, contagious and infectious diseases, the dangers arising therefrom are considerable. But undertakers are exposed to a still greater risk, namely; that of *handling* the remains of those who have died from the effects of those same diseases. Not only do they have to guard against the infectious character of the contagion, but they have also to protect themselves against the malignant effluvia which emanates from the victims of the contagion after disintegration of the body has taken place, the nauseous and sickening gases which are generated by decay, and the deadly virus which may be innoculated into the system, either through some puncture or abrasion of the skin; the virulent effects of the poison may be carried carelessly to the mouth, the nose, or the eyes by a thoughtless action. Too much care cannot be exercised by undertakers in handling a corpse, especially if the subject is known to have been afflicted with some infectiuous or malignant complaint.

Still the precautions generally in use among undertakers, and the different preparations that are commonly recommended as preventatives, are useless in most cases, as there are conditions of the system which will increase the danger, and in some instances leave it open to the insidious attacks of disease and contagion. Too much importance has been attached, by far, to the artificial means devised by some, under the names of preservatives, antidotes, etc. The reliance placed on them in a great many cases, has proved futile, and although some possess real and undisputed merit, they proved ineffectual, when the system has been influenced by the following: *Conditions of the system*, which will increase the danger of contagion: *Fear.*—Almost in every case, if a person is brought in sudden contact with the remains of one, who has died of either cholera, small pox, yellow fever, or any of those terrible epidemic and contagious diseases, which will in a few weeks decimate a populous city; the feeling will be one of repulsive horror. In some this feeling will amount to absolute fear, which will show itself in the dilated pupil, the bleached countenance, and the momentous

forebodings which assail the mind, and predispose the system to the attacks of the disease. In this case, the mind influences the body to such an extent, that the disease has already fastened itself upon the system before the first symptoms are felt.

Another and potent cause of danger is that which proceeds from a debilitated condition of the system, the causes of which are numerous; over-exertion of either the body or the mind; labor carried on incessantly without due regard to relaxation; imperfect nutrition, or long fast; all are causes which will tend to render the system more vulnerable to the aggression of sickness.

But the most pernicious and fatal of all mistakes, is that of using *stimulants* to ward off the effects of contagion. How many of our professionals and their assistants have given way to the use of ardent spirits, under the delusion, that it was absolutely necessary, to avoid the noxious effects of infectious diseases. It is a well authenticated fact, and one worthy of notice, that persons who generally indulge in the use of spirituous liquors, even in a moderate quantity, are those who are first attacked by epidemic or contagious diseases, and who almost always fall victims to it. Take for instance, the case of a surgeon about to perform a dangerous operation. His first inquiry will be about the habits of the patient; he knows well enough that a man addicted to drink will not bear up under the trial.

The only means we have to protect ourselves from the dangers of infection from dead bodies are: *first*, a perfect ventilation of the room where the remains lie, so as to obviate the bad tendency which the air of the death-chamber might have upon the system. Attention must be paid to the diet; the food eaten should be generous and nutritious, and it is proper to take a *small quantity of wine*, at a time when the body and mind are debilitated by long and exhaustive manipulation of the dead, but avoid all excess of fluids or solids. *Temperance is strictly necessary.*

Wounds received while handling a corpse should not be neglected; if a simple abrasion, it should be covered; if pricked, the liquid muriate of ammonia, or caustic potassa are recommended to be applied as cauteries. These are the early measures to be pursued; but after absorption has taken place, a different course must be practiced, and a good physician consulted without delay. The garments ordinarily worn should never be brought in-

to direct contact with the remains of a person tainted with some infectious disease.

But it is to *the hands* we must pay particular attention. *Gangrenous* or *syphilitic* sores may be found on a subject, in which case, extreme caution must be exerted; the hands should be first *well rubbed* with *lard* or *sweet oil mixed* with *carbolate* of *camphor*, and thoroughly washed after the handling of the body is over; then the hands should be well soaked in *chlorinated soda* (so called Labarraque solution) as the disinfecting properties of chlorine will be found here particularly useful.

If the above suggestions are faithfully followed, they will be found to greatly diminish the dangers attending the handling of the dead—dangers which can never be entirely avoided.

PRACTICES WHICH MUST BE ABOLISHED.

Some usages which seem to be sanctioned by long practice, but not by any remarkable amount of good judgement, ought to be discountenanced and done away with, simply upon the ground, that these acts conflict directly with all sanitary law, and, to a great extent, endanger the lives of the persons who may be present. Still, these repeated transgressions upon the common precautionary measures against contagion are not the result of a desire to do wrong, neither do they always arise from sheer ignorance, but they are almost always caused by an utter disregard of even the simplest prudence.

For instance, how often, where a child has succumbed to the attack of some infectious disease, like diphtheria, scarlet fever, etc., will parents, regardless of the contagious character of the disease, insist upon kissing the pallid lips of the corpse, and moreover, invite other children to follow the same dangerous practice.

And again, another prolific source of disease lies in the fact, that funeral services will be conducted in a close, warm, ill-ventilated room crowded with a sympathizing audience, in close proximity to a corpse emitting foul and infectious effluvia, and inhaling these into the system. It is true, that these same noxious gases may not always be detected by the smell, as the floral ornamentations, the crowded state of the room, etc., all tend to dis-

guise any unpleasant odors; but the germ of contagion is still there and actively at work.

It is a fact, patent and undeniable, that carelessness in the keeping and disposing of bodies, is an act of guilty neglect, and the sooner the community be made acquainted with the dangers attending such practices as those above spoken of, the better it will be for the enforcement of those sanitary measures, which are necessary in every well-regulated city or town.

We have already spoken of the dangers to be encountered in the handling of bodies, but the subject is of so much importance to undertakers, and concerns the profession so closely, that it may not be amiss here, to renew our former cautions; also, to add a few more suggestions, so as to modify the danger thereof, even if it cannot be completely eradicated.

FORENSIC MEDICINE.

Although this subject may be considered by a large majority to be irrelevant of the knowledge usually ascribed to the undertaker for the perfect discharge of his professional duties, it is nevertheless proper for the reader to be made acquainted with the technicalities and facts which he may at any moment be called upon to answer in a manner consistent with the care, and so frame his words, that his hearers be impressed with a sense of trust in the reliability of his testimony. It is therefore, well for the intelligent professional to be prepared (should occasion demand it,) to furnish in a clear and lucid manner his quota of information when it is required of him, and how much better can it be done by familiar study of at least the first rudiments in that branch of medical science, which has for its name forensic medicine. If we have extended ourselves at some length upon the subject of Toxicology, we had in view two distinct purposes: *first,* to protect the undertaker from danger, by a thorough knowledge of some of the drugs and substances he may be called upon to manipulate; *second,* to so instruct him in the symptoms, effects and antidotes of the same substances that he may be able to escape the stigma of complete ignorance, where often times his evidence in a court of justice may be of real importance.

Forensic medicine, or medical jurisprudence, may be said to include every branch of medical art, and every fact in the wide domain of medical science. A witness in a court of law may be asked questions, the correct answer to which may presuppose an almost omniscient acquaintance with the facts and theories of anatomy, medicine, surgery, etc. In order to the detection of crimes of all kinds, it is almost evident that such "a circle of sciences" could never be comprised within the limits of this book. Toxicology alone, of which we have only seen the most prominent features in a superficial manner has now a voluminous literature of its own, and is justly considered a division of this subject. They fear to begin the study of forensic medicine, because it appears to them a labyrinth of indigested facts and theories far too bewildering for men of average abilities and ordinary leisure. The evil of this state of things are, that many of our professionals feel conscious of painful and ridiculous exhibitions of ignorance in courts of law; ignorance which it is to be feared has too often led to a failure of justice. The object of the within are given, as outlines of the current knowledge of the day on those topics which are most frequently the subject of inquiry and also the controversy during civil or criminal trials. Some of the chief practical issues you may be called to testify upon, are:

1.—On the identity of the dead subject.

2.—The fact of death itself.

3.—The cause of death according to post mortem appearances, —whether by the ordinary course of nature, disease or violence, by poison, strangulation, drowning, etc., and if by any of these, what are the proofs?

First.—Make yourself as fully acquainted as possible with all the facts of the case upon which you have to give evidence; carefully examine the clothing, if any, and all the surroundings of a dead body.

Second.—Avoid all flippancy of manner. Even if no serious issues are at stake, your own sense of propriety must lead you to spare the feelings of the friends or the relatives of the deceased as much as possible; at the same time a man's natural manner is best, and we deprecate all assumption of preternatural gravity.

Third.—Arrange what you have to say, especially the post mortem symptoms you may have observed.

Fourth.—Use the plainest English you can, and never strive to

appear learned by the use of scientific or cant terms; let the result of a blow be a bruise rather than a contusion; speak of a blood clot rather than of apoplectic extravasation.

Fifth.—Do not answer any question unless you both hear it and clearly understand it.

Sixth.—Never lose your temper in the witness box: be as cool and imperturbable as possible.

Seventh.—Avoid prolixity and useless repetition, volunteer as little evidence as possible, but keep back no part of the truth.

Eighth.—Keep your opinions, together with all disputed circumstances quite separate from those facts which you have yourself observed, or which are satisfactorily proved by the evidence.

Ninth.—Whilst avoiding undue hesitation as you would undue haste, take time so to frame your answer that it may convey your real meaning, and be easily understood.

Tenth.—Take care that your depositions are read over to you, before signing them.

For the examination of bodies found dead, we refer you to the chapter of *post mortem* examinations, also before you disturb the body, carefully note its position and surroundings, and the position of blood stains, if any. We now come to matters of detail and observe:

1. That you should carefully examine and note the attitude of the body, to see if there be anything suggestive of a struggle, or violent death by poison or otherwise; look for weapons, or traces of blood, or for cups or bottles which may have contained poison; for example prussic acid is often given and taken in beer, and arsenic in tea or coffee, or in solid articles of food.

2.—Is the body clothed? wholly or partially or naked? are the clothes injured or stained?

3.—Note carefully the position of the limbs; are they rigid? (See rigor mortis.) If the fingers or toes are clenched; see if there is anything held between them; examine the nails also; in struggles, hair or portions of skin or clothing may be found, whilst in drowning, sand or weeds may be met with.

4.—Carefully note the color and expression of face. Are the eyes dreadfully staring, or decently closed; are the pupils large, small or unequal; is the mouth open or the teeth clenched; is there froth about the mouth or any particular smell (chloroform or prussic acid?) The face will generally be livid after

apoplexy, suffocation, hanging, etc., or when much struggling has preceded death, or in natural deaths in which the lungs; right heart and venous system are much gorged. It is however, usually pale after death from acids, as prussic acid, alkalies, most vegetable poisons, blows upon the epigastrium, and injuries to the vital organs. On the other hand, poisoning by alcohol, opium, oxide of carbon and chloroform, it may be either red or pale. In most violent deaths, and after severe hemorrhages, the features are convulsed. Apoplexy, opium, carbonic acid and other narcotics, often give a calm look, whilst corrosive poisons, especially those producing severe abdominal symptoms, frequently give a pinched and curious expression. Note the condition of the gums and teeth; has the tongue been bitten.

5.—Now remove all clothes from the body; see if any urine, faces, semen, or any other discharge has taken place.

6.—Examine carefully for external wounds, marks or burns, blisters, etc.; if there be any marks of a cord around the neck; should you find a cord, note where the knot is, front or back, as in suicide it is generally in front. Dr. Letheby has pointed out that wounds inflicted after death generally dry and discolor around the edges, acquiring a brownish parchment-like appearance.

7.—Note all circumstances tending to throw any light upon the time and mode of death: first, the temperature; second, the amount or absence of rigidity; third, the extent of putrefaction, or other change. (See Signs of Death.)

THE RIGOR MORTIS.

It is proper to note whether or not the body is in the condition of post mortem rigidity. More attention has, perhaps, been given to this post mortem condition than it well deserved. According to Kuhne, the rigor mortis is produced by a change in the muscular fibres; the fibres first lose their contractibility, then there is the coagulation of the myosine, and loss of elasticity. When this acidity has reached its height, the muscles become softer and the rigor mortis gradually disappears; finally, the acid condition is succeeded by an alkaline fermentation, and decomposition ensues.

The rigor mortis generally begins in the muscles of the lower jaw and back of the neck; it then extends to those of the face, neck, thorax, arms, and finally the legs; it usually disappears in the same order; it generally begins in from eight to twenty hours after death, but often much sooner. The bodies of persons killed on the field of battle, and of those who have been drowned, sometimes seem to be overtaken by the rigor mortis at the very instant of death; the bodies retain the same position, and the face the same expression, which they had in the last moments of life. The rigor mortis may continue for from one to ten days, generally, but not always. Death from narcotic poisons is followed by a short and feeble rigidity, while death by lightning is followed by rapid and intense rigidity; in young children it is feeble and of short duration. The degree and duration of rigor mortis after death from violence, from different diseases, etc., is stated so variedly by different observers, that no rules can be given concerning it.

The temperature of the normal living body is 98° to 99° F. In illness, the temperature may be increased several degrees. After death the body usually cools to the same point as the surrounding air; this is said to take place in from fifteen to twenty hours.

Taylor, from the examination of one hundred bodies, states that the average heat of the skin of the abdomen, at a period of two or three hours after death, is 77°; at four to six hours, 74°; at six to eight hours, 70°; at twelve hours, 69°. The internal viscera retain their heat longer than the surface of the body.

It is said that after sudden death from accidents, apoplexy, acute diseases, and asphyxia, the body retains its heat for an unusually long period. It is both asserted and denied, that after death from hemorrhage the body cools rapidly; the body of an adult cools more slowly than that of a child or an old person; that of a fat person more slowly than that of a lean one.

In some cases there is an exceptional retention and even an increase of heat in the dead body. Dr. John Davy reports, that in a case of death from rheumatism, after the viscera has been exposed for several minutes, the temperature of the left ventricle of the heart was 113°, and that of the liver 112°. In a second case, six hours after death, the temperature of the heart was 108°. It is stated that after death from yellow fever and chol-

era, the temperature increases for several hours after death. There are also recorded a number of instances in which the body retained its heat for several days, without known cause.

It will be seen from what has been said, that if we are called upon to pronounce the length of time that has elapsed since death, in a given case, this is only to be done approximately, and it is probably necessary to take into consideration the cause and manner of death, the condition of the individual, the state of the atmosphere, the manner in which the body has been kept after death; and even after making these allowances, we can only say that a person has probably been dead for such and such a time.

BURYING ALIVE.

SIGNS OF DEATH—POST MORTEM RIGIDITY—PUTREFACTION—ORDER OF SIGNS OF DEATH.

Such cases have happened, particularly in cases of yellow fever, cholera plague, or in hot countries, from the practice of burying on the day of, or the day after death. What, then, are the signs of death? Briefly they are as follows:

First.—Entire cessation of the heart's action, not for a few seconds only, but continuously. Mere absence of the pulse at the wrist, or even in other arteries, is not enough, as this may be found in cholera, abdominial collapse, and other kinds of shock, etc. Careful auscultation and palpitation of the heart's region in a quiet room, alone can decide the absence of cardiae action. In doubtful cases it would be better to employ the stimulus of a galvanic shock to the heart's region. It should be remembered that there is a "pulse" whenever an artery is superficial enough to communicate its stroke to the exploring finger, as in the facial, the carotids of the neck, the brachial, radial, ulmar, femoral, and anterior and posterior tibial arteries. There are many instances of the recovery of children and infants after the heart had apparently ceased to beat for at least a quarter of an hour. The heart, and especially its right auricle, seems to have a life of its own, distinct from the great nervous centers, and continues to beat or contract, even when cut in fragments, for some minutes after its removal from the body. The presumption of death, when this

last part of the body no longer gives signs of life, must therefore be very strong.

Second.—Entire cessation of respiration. The act of breathing is so eminently a vital one, that any long suspension of this function can not but be fatal. Here the Stethoscope should be used, as careful auscultation is more likely to detect the noises made by air, or air and mucous, or other fluids traversing the air tubes, than any other means. The use of the looking-glass to condense the moisture of the breath, or of a feather, or other light body, to indicate the movements of air, are popular but not very reliable methods of ascertaining the continuance or otherwise of respiration.

Third.—Changes in and about the eye.

1.—An entire insensibility to light; the pupil no longer contracts or dilates, according to the amount of light thrown upon it. The best mode of testing this is known to apthalmic surgeons as oblique illumination. A bright light is placed on one side of the eye to be examined, and its rays brought to a focus by means of a double convex lens of about two inches focus, and the lens and light so disposed that this focus falls upon or nearly coincides with the pupillary aperture. When no change is produced, the iris remaining immovable, we may then usually conclude that life is extinct.

2.—There is an entire loss of sensibility to touch in the ocular conjunctive. This is, however, equally true of a period in epileptic fits, and in some cerebral injuries.

3.—The conjunctivæ covering the sclerotic begins to show a gray, cloudy discoloration on its external portion, which soon becomes blackish. Mr. Larcher considers this phenomena as due to putrefaction changes.

4.—The cornea speedily loses its transparency; in other words, the eye has lost its lustre. This change, however, may take place in life, as in cholera and other diseases.

5.—The eye soon becomes sunken in the socket, and the globe itself becomes flaccid, so as to retain the dent or mark of any pressure made upon it.

6.—Mr. Bouchert states that beads of air or gas, in other words an interrupted column of blood, will be seen in the retinal veins, resembling bubbles of air in the colored fluid of a spirit thermometer.

7.—At the same time the eyelids will have lost their elasticity, neither they, nor the globe of the eye moving any longer.

8.—It is said that atropine or calabar bean no longer produces the contraction and dilatation, which are their respective properties. This is true of a body dead some days, but not so of a body dead only a few hours.

9.—Electric and mechanical stimuli equally fail to effect the eye of one dead for some time.

Fourth.—Changes in the temperature of the body. Gradual cooling or loss of heat is the most common change after death; in some diseases, however, the temperature of the body rises after death; as in cholera, yellow fever, tetanus, rheumatic fever, small pox, etc.

It is a familiar observation that the body cools more or less rapidly, according to the external temperature, the amount of clothing and other accidental circumstances. It has been stated by Messrs. Durand and Limas as a result of numerous experiments, that from eighteen to twenty-four hours are required for the body, under ordinary circumstances, to cool down to the temperature of the surrounding atmosphere. As these observations have not been published in English, we subjoin a summary thereof, which are taken seriatim from one hundred and thirty-five persons dying of various diseases. It is the axillary (or under the arm pits) temperature of the body:

TEMPERATURE OF THE BODY AFTER DEATH.

	2 to 4 hours.	4 to 6 hours.	6 to 8 hours.	8 to 10 hours or more.
Maxima.....	109.4° F.	98.2° F.	95.3° F.	100.4° F.
Minima.....	89 6° F.	80.6° F.	70.5° F.	62.6° F.
Average	96.9° F.	90.2° F.	81.7° F.	77.9° F.

The following seem the chief practical conclusions from these and other facts collected on this subject:

First.—That in the winter the human body takes several hours —certainly not less than four, sometimes twelve and even more, to cool down to the temperature of the surrounding air, especially if internal temperature be observed.

Second.—The external temperature, the amount and kind of clothing, and the position of the body, all modify the rate of cooling. The cooling seems to depend upon: (*a*) The cessation of heat produced by vital or chemical processes; (*b*) Radiation;

(*c*) Conduction and convection by cool air, cold ground, stone, wood, articles of bedding, and other substances upon which the body rests, or by which it is surrounded.

Third.—Age or sex seem to modify this process but little.

Fourth.—The mode of death has far more to do with it. Large losses of blood seem to cause rapid cooling; but Dr. Taylor has shown that it is not invariably true.

Fifth.—Several minor phenomena, or so called tests for death, have been observed and may conveniently be grouped as follows: (*a*) If scarificators and cupping glasses be applied to the pit of the stomach blood usually flows, but it will not do so after death, at all events not many hours. (*b*) It is stated that a burning match, hot sealing wax, cantharides solutions, or blistering fluids, no longer produce vesication; here again, there is a fallacy, as such results may happen in young and healthy subjects, although not after the second or third day. (*c*) The fingers and hands, especially in young subjects, are translucent during life, but become opaque after death. (*d*) A string tied tightly around the finger of the supposed corpse, will, if life be not extinct, soon cause the finger to turn bluish-red.

CHANGES BY PUTREFACTION AND THE EVOLUTION OF GASES.

These become evident to sight, smell or chemical tests. The earliest signs are a greenish or greenish-purple, or yellowish-green discoloration of the abdomen. This extends next to the genitals and other parts of the body. The changes of the eyes have already been given. Next, gases of various kinds are generated in more or less abundance, and give the corpse a bloated appearance, especially distending the abdomen; in some cases, these gases are highly inflammable. These gases tinge both the exterior and interior of the viscera in a remarkable manner, often resembling the effects of poison. The color of the blood in the veins and heart may also be changed by these spontaneous decompositions.

The force of the gas generated has been sufficient in some instances to empty the heart and great vessels—even it is said to expel the fœtus from the uterus, and to burst the coffins even when made of lead, in which such bodies had been enclosed. There is a popular idea prevalent that it is common for bodies to burst, but this is the reverse of the truth. With a view to economize space, we have constructed the following table:

TABULAR VIEW OF THE CAUSES WHICH EFFECT PUTREFACTION.

THINGS WHICH FAVOR PUTREFACTION.	THINGS WHICH RETARD PUTREFACTION.
Temperature between 70° and 100° F.; therefore, summer weather and warm rooms.	Temperature at 32° F. and below; cold weather and cold rooms.
Moisture—brain and eyes soon putrefy; so do dropsical subjects. Low, swampy ground.	Temperature above 212° F.; hemorrhages; if very profuse; complete, or nearly complete immersion in water.
Free access of air; a shallow grave; absence of clothing.	The body being protected by clothing, or other covering; a deep grave.
Previous injuries and diseases; bruises, wounds and inflammation.	Burial, especially in dry sand or earth, and burial very soon after death; dry elevated ground.
Sudden death; acute diseases.	Poisons, as arsenic, alcohol, chloroform, strychnine, etc.
Childhood; the female sex; especially after child-birth; corpulence.	Certain gases; nitrogen; perfect air-tight caskets; leanness.
Animal poison; prussic acid; poisonous gases; oxygen.	Old age, unless corpulence; lime, as opposed to popular views.

You may ask how soon after death can putrefaction take place? Your answer must be, that, under favorable conditions, it may supervene within a very few hours after death, certainly within five or six hours after death, even to the production of vesications. Besides, the color changes, and development of gases in putrefaction; the following alterations in the body are caused by it:

The diaphragm is forced up by the distended bowels; the blood is forced toward the head and neck; the face swells; the eyes, which had been sunken, now become horrible prominent, and collapse at a later period. Mucous; bloody froth; the contents of the stomach and lungs come out at the mouth—rarely the contents of the bowels escape; blood, or rather blood-like fluid, exudes from ruptured vessels or old wounds; loose tissues (eyelids, scrotum, penis, the great labia) are distended; the hair, nails and scarf-skin easily become detached. Portions of the

body have been luminous after dark in some cases, generally in advanced stages of consumption, or wasting disease.

DISINFECTING PROPERTIES OF ACIDS.

1. CHLORIDE OF LIME.

Application.—To destroy putrid gases and check putrefaction.

How used.—A solution of chloride of lime made by straining or decanting a gallon of water into which a pound of the lime has been dissolved, is a good disinfectant fluid to use in washing the bodies of those who have died of small pox, cholera, scarlet fever, measles or any other disease. It is a good solution to use in the sick room for cleansing the hands of the nurse, and into which small articles can be immersed which are awaiting an opportunity to be boiled.

To generate chlorine gas, pour strong vinegar or dilute sulphuric acid upon chloride of lime placed in pans in the room. Or, place in an earthen vessel four ounces of peroxide of manganese and pour upon it one pound of muriatic acid.

Chlorine gas is regarded as an efficient disinfectant, but it, must be efficiently applied. It is very efficient in disinfecting confined or infected atmospheres and porous substances. Its rapid diffusion and power of penetration are great. It destroys sulphureted hydrogen, ammonia, and all fetid organic compounds. Its odor penetrates far beyond its power as a disinfectant, hence its real degree of influence may be deceptive. It can appropriately be used in disinfecting ships, ship baggage, foul cellars, and rooms unoccupied.

2. PERMANGANATE OF POTASSIUM.

Application.— To disinfect temporarily soiled articles from the sick room until they can be boiled or washed.

It should not be used in connection with carbolic acid. This article forms the principal ingredient in "Condy's Disinfecting Liquid," of the shops.

Articles should be immediately boiled upon removal from this liquid.

The solution should be made by dissolving one ounce of the permanganate in three gallons of water.

3. CHLORALUM AND BROMO-CHLORALUM.

According to analysis of these compounds, the most valuable element they contain, and the one to which they owe largely their disinfecting property, is the chloride of aluminum, which of itself is a very efficient disinfectant.

How used.—Dilute with eight or ten parts of water and place in vessels in the sick room, or saturate towels with the diluted solution and hang them in the sick room, as it possesses the advantage of being odorless.

4. CHLORIDE OF ZINC. SULPHIDE OF ZINC. SULPHATE OF ZINC.

Application.—These salts of zinc are used in solution precisely the same as the permanganate of potassium is used. They are all poisonous, but are regarded as good disinfectants. The solution needs to be made strong—two ounces of zinc to each gallon of water used. If the solution is very strong, damage may result to the clothing immersed in it. Articles immersed in these solutions should be boiled without much delay.

These solutions are especially adapted to the disinfecting of sewage.

5. IODINE.

Application.—For the deodorization and disinfection of fluid and semi-fluid substances undergoing decomposition, iodine is well recommended.

It is claimed to have a destructive influence over the virus of small-pox, for which purpose it can be exposed, in small quantities, upon a plate in the room.

A solution of iodine, two grains; iodide of potassium, twenty grains, and water, four ounces, kept in an open vessel, at a high temperature, has been employed in the sick room of scarlet fever patients as a useful disinfectant.

6. CARBOLIC ACID.

Application.—Mixed in the proportion of one part of acid to from forty to one hundred parts of water, carbolic acid has a wide range of application as an antiseptic and disinfectant.

For purposes of thorough destruction of disease germs, a solution of not less than two per cent. of the acid should be employed. When used to disinfect clothing, a solution of one part of the acid to one hundred of water would be an appropriate strength.

To guard against damage to the clothing by the contact of particles of undissolved acid, a quantity of strong vinegar, equal

to the amount of acid used, should be added to secure its complete solution in the water.

Disinfection in a room, as is almost always practiced with a spray of carbolic acid, is a mere deceptive procedure. The quantity used is too small to produce any effect upon the specific contagion.

These have long been supposed to possess the power of decomposing contagious matters, or in some mode, of depriving it of its virulence. It was the custom to dip letters and papers which arrived from places where pestilence was prevailing in *vinegar*. Clothes and goods of all kinds coming from lazarettos, are exposed to the vapors produced by the slow combustiou of sulphur (sulphurous acid.) But the former being thought too feeble, and the latter having been found exceedingly irritating to the lungs, they are rarely employed for general purposes; and when acids are used, either the muriatic, the oxymuriatic (chlorine,) or the nitrous is resorted to, though the employment of any of them in an inhabited appartment is not attended with serious inconvenience to patients and attendants.

Muriatic acid was first employed by Guyton Morreau in 1773, to disinfect the principal church of Dijon, the air of which had become so contaminated by the emanations from the vaults below, from which, on account of their crowded state, the bodies had been removed, that it was unfit for Divine worship. *Vinegar*, *aromatics*, and the *deflagaration of nitre*) had been tried, but without effect; but the vapor arising from the *decomposition of six pounds of common salt* by *two of sulphuric acid* deprived the air in *one day* of *all unpleasant odors*, and in four days afterward worship was performed. This distinguished philosopher toward the close of the same year, used fumigations of muriatic acid with complete success for disinfecting the prison of that city also, whither fever had been imported from other cities. The preparations recommended are *12 parts of sulphuric acid*, to *15 parts af nitrate of soda*, which should be slightly moistened before the acid is poured upon it.

Oxygenated muriatic acid (chlorine) was first proposed as a disinfecting agent by Pomeroy in 1871. It was soon after employed by Cruickshank, and it has since united most suffrages in its favor.

There is an exellent and concise account in the 18th volume of the Journal of Science and the Arts, of the disinfection of the Millbank penitentiary, by Mr. Faraday. The following are the material points of the process: He found that one part by weight of common salt, and one part of oxyde of manganese, when acted upon by two parts of oil of vitriol, previously mixed with one part of water by weight, produced the best results. The salt was bruised down with a mallet previously being mixed with the manganese; and the acid and water were mixed in a wooden tub, and allowed to stand for some hours, that the heat produced by their combination might be dissipated before they were poured on the other ingredients. Common red pans (crockery) of a flat form, were used for the fumigations. The evolution of chlorine commenced a few minutes after the ingredients were mixed in the pan, and continued for four days, no extraneous heat being employed in the operation. The quantity of material used were 700 pounds of salt, 700 pounds of oxyde of manganese and 1400 pounds of sulphuric acid, whilst the amount of space fumigated amounted to nearly two million cubic feet and the surface of the walls, floors and ceilings was about 1,200,000.

The subject would be left imperfect, did we not inquire into the extent of the power and the mode of action of acid fumigations to which class, we include *chlorine*, either directly applied, or furnished by the chlorides. Though not ignorant that the title of chlorine being considered an acid is disputed by many chemists, and though there may be still some doubt as to the mode in which the chlorides affect atmospheric impurities, it will be understood at once, that these agents can produce a beneficial effect only in a limited quantity of air, and that no epidemic constitution existing in the atmosphere of a district or country can be corrected by them. If they are to have any effect in checking the propagation of miasmatic diseases, such diseases must be existing in a limited space. All the stronger acids, as we know, possess the power of corroding the animal texture; and their property acting on contagious matter, which is of animal origin, may depend on this property, or on their quality of absorbing or decomposing the noxious gases, which are probably powerful vehicles of contagion, as it is ever found to be at least active in the purest atmosphere. That in a limited atmosphere, they promptly destroy bad odors, is well ascertained,

and all fumigations, that of chlorine, in this way, is the most efficacious; but on what this property depends does not seem to be well understood in the case of all of them. Chlorine combines readily with hydrogen, and combines with or decomposes its compound gases. It decomposes, too, ammoniacal gas and hence, there is not much difficulty in understanding how an agent which acts promptly on those gases, the result of putrefaction, and affecting strongly the sense of smell, should be powerful in correcting the more obvious nuisances of infected appartments. But it is not so clear how certain of the other disinfecting agents, muriatic acid, for instance, the affinity of which for septic gases is less general than that of chlorine, remedy such nuisances; though the experience of Guyton and many others, places the fact, that they do so, beyond all question.

It is obvious that all solid matters which are in the affected apartments will receive the influence of the fumigations employed to purify the air. In addition to this, they should be washed with soap and water, the walls should be whitewashed, the air be freely admitted for some time previously to the room being again inhabited. All body and bed clothes surrounding those who have died of infectious fevers should be thrown at once into hot water, and after remaining there for some time should be thoroughly washed with soap or an alkaline lye. They should then be hung in the air for a considerable length of time, and they may be occasionally sprinkled with the liquor or chlorinated soda. Too much care cannot be taken by persons who are in the daily practice of handling the dead. Gases of a more compound nature, and still more deleterious properties, are often emitted in great abundance from putrefying animal substances, especially from burying grounds.

A striking account from the remarkable effects produced by the exhalations from opening graves, has been given by Fourcroix. It appears, from the report of the grave diggers, who were examined on the occasion referred to, that those men who happened to be standing immediately over a corpse, of which the abdomen was suddenly struck into by a pickaxe, often fell down on a sudden in a state of apparent death; while those who were at a greater distance, and received the noxious effluvia in a more diluted state, were attacked with nausea, giddiness, tremors and faintness, which symptoms continued for several hours.

THE LABORATORY.

Before fully entering upon the subject of embalming, it may not be out of place to make mention of the room devoted to that purpose.

As a general thing, undertakers will find it to their advantage to have set aside, either in the rear part of their store, or at some other convenient point of the building, a room of moderate dimensions, exclusively for the purpose of preparing bodies. It may also be used either for the purpose of holding inquests, post mortem examinations, or as a morgue.

Although the purpose for which it is intended, be that of a laboratory or room where the bodies for embalming is carried on, undisturbed by the traffic of the office, it will be found very useful for the above named object. Very often physicians, who may be wanting to investigate the immediate cause of death in some of their patients, and who can not prosecute the necessary investigations either in their own office or at the house of the deceased will avail themselves with pleasure, of the opportunity thus offered to them. The advantages of this arrangement to the undertaker are obvious and require no explanation.

The room shall be well ventilated and lighted, and everything so arranged as to be within reach; a sink with a water faucet shall occupy a corner of the room; in the center an embalming board, with longitudinal grooves, on trestles, the head elevated about a foot higher than the feet, so as to allow all liquids to run down and be collected in a pail at the lower extremity, without unnecessarily soiling the floor; a closet or cupboard for chemicals which, by the way, ought always to be kept locked up. It is also necessary to keep a certain amount of the preparation used in daily practice, already mixed for use at a moment's notice. The preceding recommendation will prevent mistakes, and do away with the confusion attendant upon a hasty call. A very useful custom, and one that cannot be too highly praised, is that of keeping all needful articles for laying out and keeping a body, in a satchel, which can be carried about in the hand, without the least inconvenience. The contents shall include all that is necessary to preserve bodies, say for five or six days, without the use of ice. The annexed list will furnish the explanation.

Two sponges for washing purposes; these shall be thoroughly

cleaned after using. A small post mortem case, containing a cartilage knife, two scalpels, two catheters, one pair scissors, forceps or nippers, hook to raise arteries and four crooked needles assorted, also a skein of surgeon's silk. These instruments shall be carefully cleaned before returning to the case.

Two pint bottles fluid for injecting stomach and bowels and one pint bottle fluid for the complexion (bleaching fluid) it can be diluted to suit, when using.

Some cotton for stopping air passages and rectum. Two cups for collecting blood from the jugulars, should the veins be so congested as to require emptying of their contents, a few bandages, oiled silk cloth 12 x 18 inches.

A rubber syringe for injecting either the stomach, lungs or bowels with injecting needle, flexible tube, arterial tubes, and trochar, this should be well cleansed after using, and also the leather forming the head of the plunger be saturated with glycerine; it will keep it moist and free from getting sticky, which may happen when oil is used. A bottle of some pungent, aromatic liquid which will serve to disguise the smell, always more or less unpleasant near a corpse.

An eight ounce bottle containing tannic acid to dust in cavities of the thorax (chest) or abdomen before closing the wound.

A one ounce bottle of liquid muriate of ammonia, which is invaluable to cauterize any scratch, abraison of the skin, or cut on the hands of the operator while at work. Also some adhesive plaster.

STATE OF BODY AFTER DEATH.

As a most important matter, the conditions of a body as influenced by the cause of death, should be made a study of and fully understood, before proceeding any farther. These different circumstances may so influence the state of the body, that the process of embalming, as given hereafter and as usually practiced, may not be successful. I repeat an assertion already made, that one body having been treated successfully in a certain manner, yet the same method may fail in another case, although the same chemicals may have been used in both instances, and given full satisfaction in the first, they failed to accomplish their object in the last. It is a well known fact that the arterial system

must be intact and without lesions, if the injecting fluid is to be carried in a thorough manner, and by the natural channels through the body—therefore any rupture in the arteries may cause the fluid to escape at that point, and fill the neighboring cavities. The result would certainly not in that case be satisfactory to the operator; for as the fluid would thus be arrested in its course, and fail to permeate the tissues through the arteries, veins and smaller vessels, the corpse would soon putrefy in consequence. Destructive inflammation of the surrounding tissues may invade and destroy the walls of an artery. Thus, ulceration of the brachia, may perforate the aorta, gangrene of the lungs, ulcer of the stomach, etc.

Let us suppose that the operator chooses the femoral artery as a point of injection. The injecting fluid will fill the arteries of the abdomen and chest until it reaches a point where the walls of the arteries are ruptured, and then will lose itself into the surrounding cavities, thereby failing to reach the upper portion of the body. It will of course, in an instance of this kind, be found necessary to inject again at some other point situated in a higher part of the body, as for instance the axillery artery. It is therefore easily understood that: First—The cause of death may so effect the arterial system that the point selected for injecting may not be the proper one. Second—That it may be necessary to inject the body at different points. Third—That in many cases, the cause of failure does not lay in the lack of the chemicals used, but in the need of discrimination on the part of the embalmer, in choosing the proper place for injecting, and also his ignorance of where that place should be. It is therefore patent, that should the course of the arteries and veins be not readily understood by the operator, it will be a rather hard matter for him to discover the cause of his failure.

REACHING THE PRINCIPAL ARTERIES.

To Reach the Femoral Artery.—Extend the limbs, toes up, commence the incission at the centre of the thigh, about three inches from its juncture with the groin, cutting downward in a straight line about three inches, cut but little deeper than the skin, underneath you will find some fatty tissue, which separate carefully

with the handle of lance and fingers; an artery and vein in *a sheath* will now be exposed; the *artery* presenting a *light color* and *relaxed condition*, and the *vein* a *dark, mottled color filled with blood.* The same is true of the *common carotid artery* and the jugular vein.

To reach the artery, it will be necessary to open the sheath carefully, then make an incission lengthwise in the artery, just large enough to admit the entrance of the tube, then tie the artery firmly round the tube; be sure that the tube penetrates the inner coat of the artery.

To reach the *carotid artery*, turn the head of the subject toward the *left side*, and make an *incision in the neck* about *two inches* in *length*, reaching in a *straight line* from the angle of the *jaw-bone* to the *base* of the *neck*, or *midway* between the *ear* and *collar bone;* the head should then be bent in such a way as to relax the mastoideus muscle; open the sheath, same as directed above, raise up the artery with a pair of forceps, make the incision as above, then insert the tube point *down wards*, *tie the artery back* of the *potnt of injection* to prevent escape of fluid. This artery is not often used by undertakers, as an incision on the neck is too much exposed. To reach the *brachial artery*, extend the *right arm* with *palm of the hand up*, make an *incision* about *three inches*, *above the bend of the elbow*, *between* the *muscles* and the *bone*, or raise the right arm *above the head* with the *palm* of the *hand up*, then with the thumb of the left hand placed over the muscle, cut when the *bone* is *nearest* to the *skin.* The artery will be found in the same sheath with the *basilic vein;* open the sheath carefully and insert tube in the artery as above described, *point towards* the *head* of *subject* and inject the fluid. The *axillary artery* is the same as the brachial; it is higher up, and the operation is performed by cutting at the pit of the arm. It is here found to be a little larger, and perhaps stronger than the Brachial artery. You are cautioned to watch the face closely, and see that it does not blacken while injecting. These last two arteries on the right arm, are the most convenient for embalming the bodies of ladies or children, but in bad cases you will have to use the femoral artery.

After withdrawing the tube from any of those above named arteries, tighten the ligatures firmly, powder a little arsenic in the

gash, close the orifice with a few stitches, and if necessary, conceal the same with a piece of flesh-colored court-plaster.

PRESERVATION OF ANIMAL MATTER.

The perfect preservation of animal substances presents a vast and interesting field to the profession, and having now become a most important branch of the undertaking business, it has been thought proper, to bring together under the same and general term of "*Preservation of Animal Matter*," all the various means hitherto employed in the arts and sciences, for the purpose of which we are now speaking.

The most excellent works of Lecanu, and several other authors on this subject, have furnished us with precious documents.

General Means.—Dessication could be applied indistinctly to the preservation of all animal substances which are liable to undergo putrid decomposition; but among these substances a large number can be and are preserved without having recourse to the agency of the dessicating process, and to this and four other methods present themselves, each and all of them promising specific advantages of its own, and every one also carrying with it its own mode of appliance subjective to the requirements of the case and the nature of the body to be experimented upon.

1st. Morbid animal matter can be preserved by congelation.

2nd. By preventing a direct contact of these substances with the surrounding atmosphere.

3rd. By surrounding animal substances with others, without combining together, will prevent putrefaction.

4th. By bringing them in direct contact with other substances capable of producing, by intimate combination, new compounds which render them imputrescible.

This last mode embodies in itself the fundamental principle of the science of embalming, and will form the principal portion of our study. However, and to systematize our researches, examples and deductions of this subject, we will follow automatically the plan traced at the commencement of this lecture.

Dessication can be either natural or artificial. It is natural when we depend solely on the action of the atmosphere upon the

substances to be thus preserved; for instance, the *charqui* is a method employed in some warm countries for the preservation of meat. The lean parts of the flesh of animals are cut in long thin strips and exposed to the heat of the sun, being careful to turn it over occasionally so as to completely dessicate every part of it, it is then pulverized in mortars, and the powder thus obtained packed in jars; being placed in a dry spot, this becomes a nutritious article of diet, which remains sweet, so long as it is protected from the influences of atmospheric moisture. It is artificial when produced by the heat of an oven; in this instance, the degree of heat must be so graduated as to dissipate the moisture of the substances without scorching, or causing an exudation of the albumen or fibrine contained in the tissues, as the coagulation of those two substances must remain the only objective point.

Congelation.—Some northern nations have applied this method to the preservation of meat and fish. As an instance of the preserving power of cold, it is said that a *Dinotherium*, a gigantic animal of prehistoric times, and which had undoubtedly been caught alive in the ice, was found imbedded in a glacier on the shores of the river Lena in 1802. After being freed from its icy prison, the flesh was greedily eaten by the Laplanders, although geologists concur in their statement that the animal had been thus entombed for several thousand years.

Since the exploration of the sea of ice between the rivers Lena and Kolyma, hundreds of elephants, rhinoceroses, and buffaloes have been found buried in the icy soil of those countries. Several processes for preserving meats by means of low temperature, have lately been employed with success, without the addition of any foreign substances.

PRESERVATION BY INSULATION FROM THE AIR.

It is obtained in two different ways; the first consists in surrounding the matter to be preserved with substances which effectually protect it from any contact, with the atmosphere; or according to the second, animal matter may be introduced into sealed vessels whose air, by allowing its oxygen to combine with some of the principles of the substance to be preserved, thereby loses its property to develop putrid fermentation. The first method forms the basis of the means generally employed in museums of natural history, for the preservation of specimens, by

immersing them in volatile oils. Another mode, similar to the one we are now describing, by its action and effects, consists in varnishing the objects to be preserved with resinous alcoholic solutions, as gutta percha dissolved in chloroform, sulphuret of carbon, etc., which by evaporation leave an impervious coat on the surface of these objects.

For the preservation of microscopic preparations, Mr. Pacini has proposed the following formula:

Bichloride of mercury, 1 part, chloride of iodine, 2 parts, glycerine, 13 parts, distilled water, 113 parts.

Let the liquid rest for two months, then add 3 more parts of distilled water, and filter.

Mr. Latur preserves anitomical preparations by means of a solution of iodine or bromine as follows;

Iodine 5 parts, tartar emetic 6 parts, distilled water 300 parts, *or* bromine 5 parts, tartar emetic 6 parts, distilled water 500 parts.

Mr. Moullardi proposes the following: Immerse the objects for two weeks, in a solution of corrosive sublimate 2 parts, and glycerine 20 parts; drain until dry and extend on the whole a coat of varnish as above. Glycerine however, has now become the best general agent of preservation.

The method of preserving meats and vegetables in air tight vessels is too well known to be described here; as to the various results obtained in the preservation of bodies by means of metallic coffins hermetically sealed, and without any previous preparation of the body, success so far has been the exception, but not the general rule.

The third mode of preservation, that of macerating animal substances in a saturated solution of common salt, has been known and employed from time immemorial. By adding nitrate of potash, the solution acquires the property of maintaining the red color of the tissues; it is even said to make it more intense.

For the preservation of specimens of myology, the following has been extensively used in England and always with success, for it preserves the red color of muscles as well as that of tissues. Brown sugar 5 ounces, common salt 10 ounces, nitrate of potash $7\frac{1}{2}$ ounces, distilled water $\frac{1}{2}$ gallon.

In 1872 Mr. Van Vetter proposed for the preservation of anatomical preparations a solution composed as follows:

Glycerine 1 pint, brown sugar 2 ounces, saltpeter 2 ounces, distilled water ½ gallon.

In 1873 Mr. Jaquez employed the borate of soda, boracic acid, and all the borates in general for the same purpose.

The process of preservation, applied by Dr. Morgan, which bears some similarity to that of Dr Gannal, consists in injecting into the subject a strong solution of salt and nitrate of potassa, having first emptied the circulating system of the blood therein contained, by injecting weak alcohol.

In 1866 Mr. Shaler brought to public notice a new mode of preservation by means of carbonic acid, dry and chemically pure.

A number of other methods have also been used with more or less success—by repeated immersions in a solution of sulphate of alumina; gum tragacanth; acetate of soda; acetate of lime; by means of sulphurous acid (braconnat;) with the oxide of carbon (pelouze:) by saturating completely with a solution of isinglass, sugar, and gum arabic, to which 2 per cent. of fuschin was added.

Recently Mr. Redwood of London, thought it possible to preserve meat indefinitely by plunging it in paraffine liquified. To get rid of it, the meat is immersed in boiling water, the paraffine is set free by melting, and can be used again for the same purpose.

The fourth method employed for the preservation of organic animal matter, and that which most particularly must arrest our attention, and form the theme of our future studies is, the *judicious manipulation of substances*, which are capable of forming with animal matter, combinations and compounds perfectly imputrescible. *Creasote*, *alcohol*, *tannin*, *bichloride* of *mercury*, the *salts of iron*, of *zinc*, of *alumina*, *carbolic acid*, *arsenic*, the *protochloride of tin*, *thymol*, *glycerine*, the *borates* in general, *salycilic acid*, etc., are among those, best known, most frequently employed. Creasote is one of the best means used for the purpose; it is also the most ancient. Cedria, which has been made use of, in the embalming of bodies by several nations of antiquity, is analogous to the oil of cade which obviously contains a large per centage of creasote. It is then to this substance much more than to the other products of the cedrium proper, that we must attribute its preserving properties. It is also to the properties of creasote that flesh is preserved in the smoking of meats. This method carries within itself two distinct and effectual means of

preservation; first, a partial dessication of the animal substances: second, their thorough impregnation by the pyrogenous products of smoke. Creasote alone, devoid of all other pyrogenous products, possesses in the highest degree anti-putrid properties. A mixture of creasote 1 ounce, and distilled water 50 ounces, has been proposed as an advantageous means of effectually preserving anatomical preparations.

Benzine, *oil of tar*, or simply their emanations have been found highly useful in preserving animal and vegetable matter. The same may be said of *phenic acid*. *Phenic acid water*, which is a compound of phenic acid, *1 ounce*, *distilled water 50 ounces*, has proved to be a cheap and excellent substitute for *alcohol* in preserving subjects of natural history by immersion. Chloroform mixed with water in the proportion above given for phenic acid, has also shown some good results. We find alcohol most generally used in museums of natural history to preserve by immersion specimens of animal preparations. But *sugar* and *brandy* will preserve the encephalic matter *still better* than alcohol, as it communicates to it a remarkable density. The effects of tannic acid seems to be exerted almost in a specific matter upon the skin, with which it forms incorruptible compounds.

PRESERVATION OF BODIES.

The modern method of embalming is very rapid and simple when it is compared with the ancient.

A large artery of the dead body is exposed and opened, and into the vessel a hollow needle is inserted. The needle is firmly tied in its place. Through the needle a solution of chloride of zinc is injected slowly until it has found its way over every part. The principal art that is required in this process is to be very careful not to use too much force in driving the fluid into the tissues, and in not using too much fluid. The fluid which answers best is made as follows: Into two pints of water, at 50° F. add chloride of zinc slowly until the water just refuses to take up any more of the salt. Then add one pint of water more and two pints of methylated spirit. The five pints so produced are a sufficient quantity for embalming an adult body. The solu-

tion can be injected quite cold, and it will find its way readily over the vessels. If expense be not considered, pure alcohol may be used instead of the methylated spirit. The effect of the solution is shown by its making the surface of the skin white, firm, and, for a short time, slightly mottled.

The apparatus necessary is extremely simple, and lies on the table. It consists of a small ordinary anatomical case, and of an injecting bottle and syringe. The bottle will hold six pints of fluid, but it need not be quite filled. The neck of it is fitted with two tubes, which make it act like the common wash bottle of the laboratory, so that when through the tube on the right hand side, air is forced through the syringe which is attached to the tube, the pressure on the surface of the fluid forces the fluid up the long tube in the bottle and over the tube on the left-hand side. The left-hand tube terminates in a stop-cock, to which the needle that has to be inserted into the artery is joined. The tube leading to the bottle is of India rubber, of an eighth of an inch bore, and may be several feet long. Before the arterial needle is tied in the artery the stop-cock is turned off, that no fluid may pass. When the needle is fixed, the stop-cock is opened and the bottle is raised on a table three feet above the level of the lower end of the injecting tube. As a rule, the fluid will now descend by its own weight and gravitate all over the body; but if it fail to do this, the pressure of the syringe for a short time will be sufficient to carry on the current.

When the fluid has slowly diffused, until it has been all passed into the vessels, a pint of solution of silicate of soda may be injected with a syringe through the artery, by which the structures will be rendered very black, the silicate undergoing a very thorough coagulation in contact with the zinc. This final plan is, however, not really required. It is, as a rule, merely necessary to remove the hollow needle from the artery, tie the artery above and below the place where it has been opened, and merely close the opening where it has been made. The operation is now complete. There is nothing in it of a kind to give rise to any of the sensational stories which have been raised in regard to it, that is to say, when it is properly conducted. It is not more objectionable than the ordinary examination of a body to discover the cause of death.

The following process is intended to preserve bodies without

the use of ice, merely until the time of the funeral may arrive. Sometimes this ceremonial may be delayed for three or four days, or until some member of the family who may be at some distance can arrive. It is also intended to take the place of the cumbrous refrigerator, and substitute for the labor of removing ice, carrying the box to and from the residence, the more simple and less laborious process of injecting the abdominal viscera.

The first step to be taken upon arrival at the chamber of death, is to create a current of fresh air by lowering the upper part of a window, or a couple of them, if there is no transom light over the door. Next, remove the body from the bed and place it on a cooling board; this board ought to be elevated about one foot at the head; also, the head of the body should be raised at an angle of about forty five degrees; this disposition of the body will allow the fluids contained in the circulatory system to go down of their own gravitation, and leave the face, neck and upper part of the body uncongested, and therefore free from the purple spots that gradually discolor the face and neck.

The mouth must next be firmly closed, by means of a ligature tied firmly around the head and passed under the apex of the chin; this ligature should be kept in place until the rigor mortis has firmly set the jaws together.

A great improvement upon the old way of tying a cloth around the head, is to use a band of some wide, elastic fabric, of which several sizes must be kept on hand, as when this presses too tightly it leaves upon the face, especially on fat persons, unsightly wrinkles.

The eyes must next be attended to; the lids must be brought together firmly, avoiding at the same time interferences of the lashes, or the creation of wrinkles of the skin on the corner; make two small pads, not larger than the size of a quarter of a dollar, and saturate them thoroughly with the solution of the following: Alum, eight ounces; *corrosive sublimate*, two ounces; and distilled water, one gallon, before applying to the eyes. The face and the body should be washed all over with tepid water and soap, and perfectly dried with towels; make a diaper out of some cloth, fasten the same firmly around the loins, and pin the same well in front. The face should be well moistened with the above solution, and a double cloth laid carefully and evenly over the features, so as to come in direct contact with every part of

the same; this cloth must be kept *moist* with the solution and remain there until such time as the body is placed in the coffin. Fold neatly some small pieces of cotton, saturate them well with the solution, and cover over the chest and the abdomen.

Caution.—This solution should be diluted with one-half water for use on children, or persons whose skin is very fine. It must be kept also from a strong light in a glass bottle, and should, when used, never be mixed in a metallic vessel, but in a bowl, cup, or some dish of queensware or china.

The next step to be taken, consists in preventing frothing or purging from the mouth and nostrils; also, keeping down generation of gases, and swelling of the stomach and bowels.

Make an incision about four or five inches in length in the abdomen, above the transverse arch of the colon; this incision will reveal the colon and upper part of the large intestines, also the stomach a little to the left; the colon and some of the smaller intestines are punctured, and after expelling the gases and air by firmly pressing on the abdomen, are injected with about eight ounces of the solution as hereafter given; the bowels being injected, the stomach is emptied of its contents by puncturing its walls, and by pressing gently upon its outer surface in a downward direction; the matter contained in it will be forced out into the pleural cavity, and can then be either sponged or scooped out; the stomach is then injected in a similar manner as the bowels; some of the solution is then poured between the interstices of the bowels, and some cotton batting laid evenly over the bowels, the cotton well saturated with the same solution; the lips of the wound are then brought together and neatly sewed up. It will be readily understood by the above described operation that no gases can be generated in either the bowels or stomach, as the injecting fluid in those parts of the viscera will effectually prevent their formation, and this being the case, the purging at the mouth and nostrils, which is the result of the escape of gas driving out the contents of the stomach, is avoided. The expansion of the abdominal viscera, or the bowels, is also prevented by the same cause.

It will be understood that this process cannot be applied where the corpse is that of a person who has died of some contagious or infectious disease. Besides the danger to the operator in this case, it is not customary to retain for any length of time the re-

mains of those who may have died from the effects of an epidemic.

Herewith I give the ingedients of the solutions which have been found to act admirably well: *Dissolve in one gallon of water as much alum as the water will take up, shaking at intervals; then pour off the clear liquid, and add to it two ounces of chloride of zinc, and two ounces corrosive sublimate.* Keep this injecting solution in a *cool, dark place;* when the preparation is to be used in *warm weather, add one ounce of creosote* to the above.

The above process has of late been greatly simplified and rendered less laborious by the addition of the hollow needle to the undertaker's list of instruments. This little sharp-pointed steel tube, perforated at the extremity, affords alike a means of egress to the gases accumulated in the body, and also serves to introduce the preserving liquid into the thoracic and abdominal cavities. The needle, when dexterously used and skillfully handled, completely, and with advantage, replaces the knife for several reasons:

First.—The needle, when adroitly directed into the several organs, or parts of the viscera which are to be relieved from the gases therein accumulated, will effect the intended purpose thoroughly, and without having a wound of undue proportions.

Second.—It will reach deeply-set organs and cavities, which otherwise would necessitate extensive operations with the knife.

Third.—It reduces the process of preservation to a very simple operation which can be performed in a short time and without any further attention being required on the part of the operator. But if the advantages derived from a judicious manipulation of the needle will benefit the operator in the handling of the bodies, it also becomes equally inert, and almost useless, where the operator reveals his lack of familiarity with the different uses to which it can be adapted, and his ignorance of its most useful results.

We will now proceed to illustrate, as far as practicable, the process of preserving bodies by means of this useful instrument. The body being laid on a cooling board, and all preliminary details having been attended to, the needle is inserted in the abdomen at or near the umbilicus; the point is directed towards and into the stomach; a gentle pressure with the hand over this

organ will cause the gases and liquid contents to escape through the needle. This done, the instrument is drawn back about half its length, and brought down vertically, almost in a straight line with the middle of the sternum, so as to perforate the transverse part of the colon, or large intestines. The gas or any liquid then contained in that part of the viscera, will thus find an outlet. This same operation may be repeated for the other parts of the abdomen containing the small intestines, and the needle may then be withdrawn. As to the gases or liquids which may have accumulated between the intestines and the walls of the abdomen, they will escape through the needle or the small aperture caused by it. To assist in thus expelling morbid products, whether gaseous or fluid, the hand may be applied to the different parts which the needle is supposed to have perforated, pressing gently, and in such a way as to direct the escape to the outlet left by the needle. It is not expected that the solid contents of the stomach, or the fæces contained in the bowels, can be got rid of through the agency of the needle, but we consider that the properties of the fluid thereafter injected into and around these organs will arrest the putrid tendencies of those substances.

This part of the operation having been satisfactorily performed, inject through the nostrils, by means of the flexible tube, as much of the fluid as the chest will contain. This part of the process can be performed in a more complete manner by artificially reproducing the movements of respirations, while the injection is taking place through the nostrils. When the quantity of fluid thus injected has filled the trachea, further injection must be suspended, and the nostrils filled with cotton.

The cavity of the chest surrounding the lungs, and the lungs themselves, can be injected by forcing the needle under the lower part of the sternum and injecting by turns the right and left sides of the body. To inject the fluid into the abdomen and stomach, the handling of the needle is the same as above given for the expulsion of gases, and inject through the needle from the same perforation made. *Before puncturing the body with the hollow needle, stretch the skin to one side, so as to cover the opening made in the flesh after the same is withdrawn.*

It is well in warm weather not to dress a corpse in the exterior clothing until the temperature of the body has cooled off to that

of the ambient air. The use of the needle, therefore, in this instance, does away with the knife, leaves a barely perceptible trace behind, no gaping wound, suture, or in fact, any of the usual marks of surgical operations, which at all times will impress the bystander in a more or less unpleasant manner.

Another important feature lies in the fact, that the body need not be in a state of nudity to successfully apply the process; a small rent in the clothing, or an opening in the dress, however diminutive, will be sufficient for practical purposes. However when the remains of a person are to be thoroughly embalmed, the arterial injection should always and at all times precede that of the needle, for the good reason that the introduction of the needle into the abdomen or the chest is always attended with some danger to the integrity of the circulating system. The point of the needle may so wound or lacerate the walls of the numerous arteries enclosed in the thorax and abdomen, that, should a subsequent injection of the arterial tree be performed, the course of the liquid would terminate at this point, and overflow into the surrounding tissues or cavity.

In some instances, when the body is that of a stout, fleshy person, or especially when some length of time has elapsed from the time of death, until the undertaker has been called in, and particularly if the body has been reclining in a horizontal position, the face, neck and shoulders will be found highly congested with blood; the face, in fact, may be swelled and of a purple appearance, owing to the extravasation of blood into the capillary vessels under the skin.

In such cases, and after the body has been removed and placed into a proper position on the cooling board, if the blood is not carried to some lower part of the body, by its own gravitation, it may be found necessary to cut into the jugular veins, on either side of the neck, or only into one of them, an incision about a quarter of an inch; through this opening the congested blood may be let out, and the face will soon recover its original color. This process, which occupies about twenty minutes, will be found preferable to the use of ice, with the bustle occasioned in the house of mourning by carrying in and out a large and cumbrous ice box, etc.

Lecanu, in his researches on the preservation of bodies, has thus described his process: The body of a man, aged thirty-three

years, who died of typhoid fever, was brought in for dissection. The external appearance of the corpse presented strong marks of dissolution. The abdomen, already slightly tinged with greenish streaks, was distended with gas; the neck and lower part of the face showed unmistakable signs of swelling, and the evolution of internal gases caused a frothy mucous to appear at the corners of the mouth, the popliteal artery was uncovered and the conula of a syringe containing ten centilitres introduced into the vessel. *Five litres* of a fluid compound of *equal parts of alcohol, water* and *glycerine*, holding *one-fourth part of carbolic acid* in solution, were thus injected into the body. Gradually the abdomen resumed its normal size, the bluish green tint of the skin faded perceptibly. After injecting the *seventh litre*, about eleven grammes of mucous were ejected from the mouth. The operation was then suspended, and the artery firmly tied up. The canula of the syringe was then inserted and the lower parts of the limb treated in a similar manner. On the next day the incipient swelling of the head and neck had disappeared, and the discoloration of the abdomen scarcely visible. *Nine weeks* afterwards the subject was still in a perfect state of preservation, in spite of adverse circumstances, and was used in the prosecution of anatomical studies.

A body of a dead person was put in a coffin, covered first with dry bran, then filled with perfectly dry powdered charcoal, the lid was closed and made air-tight. The coffin was kept in a dry, dark place. Six months afterwards the lid of the coffin was removed and the body found perfectly preserved. There was no odor of any kind, and the features were perfect.

EMBALMING AS A SCIENCE.

Hereafter I shall have something to say of the word embalming; meanwhile, I will take for granted that each of you attaches a familiar meaning to the word, and in that sense for the moment I will leave it.

It has been a custom among ancient nations to preserve the bodies of the dead for a long period of time. Even to this day we find traces of it in the mummies of Egypt and the sarcophagi

of Etruria. Their method of achieving this result may not have been strictly in accordance with the principles of modern science; certainly their success would hardly be satisfactory to the more refined tastes of our generation. Still their discoveries in this art have been such, that they have commanded the respect of modern savants. They also show conclusively that the sciences of chemistry and physiology, even at that remote period, had attained a certain degree of prominence among their scientific men. Many of their discoveries were, no doubt, accidental, still we must give them credit for the spirit of investigation which actuated their researches, and carried them on undaunted through the many disappointments they must certainly have encountered before they satisfactorily solved the problem. A great number of persons cannot revert to the science of embalming without placing it among the lost arts; to them a mummy is the contemporary of a mysterious past, dimly perceived through the long vista of succeeding generations. Let us divest a mummy of his bitumen-coated, and fire-scorched bandages; we will then have before us a mass of blackened and hardened cement-like substance, shrunken and emaciated to almost a skeleton, and bearing semblance to the form of a human organism only so far as the shape of the osseous frame has retained its symmetry. The lips have shrunken apart so far as to expose the row of white teeth, the sockets of the eyes are empty, the bones are prominent, the whole covered with patches of the dark and almost petrified epidermis. Such is the picture a mummy presents to our view when denuded of its envelop. It is not to be wondered at, therefore, if some associate this repulsive image with the modern idea of embalming. .

Our present object in preparing bodies is two-fold.

In the first place, we desire to keep perfect for a certain length of time the remains of those who have been dear to us while living; but when dessication has begun, when the roundness of the lines loses itself into the more angular shrinkage of the tissues, then we may take, and without any feeling of horror, a last look at the body, and consign it, not to slow, foul corruption, but to the gradual drying of the organic substances, without the horrible accessions of decay and putrefaction.

In view of all this, and with the help of modern chemistry it is not singular that the art of embalming should have received a

new impetus in Europe and this country especially here, where it is customary to send back and over long distances the bodies of those that have died far from home. This usage has already brought about some astonishing results. The large majority of our first class undertakers have taken the matter in hand; they vie with each other in trying to perfect themselves in an art which is growing daily into favor. Almost every day a new antiseptic is, if not discovered, at least brought to exercise its functions in the preservation of organic substances. Of late, new methods have been inaugurated on all sides, and among the number there are certainly some, which are deserving all the merits claimed for them. To use a certain preparation simply because it is highly recommended by some, without knowing the constituents thereof, is very little short of foolhardiness. How is it possible for the operator to employ it with discrimination and judgement? Should he be successful, well and good; the end would be obtained without he being the wiser for it. Should it be otherwise, and the result prove unsatisfactory, how is he to account for the failure, and how to guard against a repetition of the same in future. A good embalmer, one that really understands his business, does not have recourse to ready-made preparations for preserving bodies, but he chooses the chemicals according to the properties each is known to possess. His experience of their relative actions teach him beforehand, how they will work out the results he anticipated. I do not mean that every undertaker and embalmer should be an Orfila in regard to chemistry, nor is it expected that his knowledge of anatomy should enable him to fill the chair of demonstrator in a dissecting room, but to achieve real legitimate success, an embalmer ought to possess a thorough knowledge of the drugs he is manipulating, their individual effects, singly and collectively, and under different circumstances, upon subjects of different natures. A certain amount of the acquaintance with the anatomy of the human body is not only required but strictly necessary; a gash of the knife upon some vessel of the arterial system might jeopardize the success of an otherwise satisfactory operation.

It is this rudimentary knowledge physiological chemistry and anatomy we endeavored to explain in the former chapters with complete instructions upon the best methods which have been heretofore and are now employed in the preservation of human bodies after death.

GASEOUS COMPOUNDS.

Too little attention has been paid heretofore to the antiseptic powers of certain gases. It is a well-known fact that some of the gases which are the result of animal and vegetable decompositions are, to a certain extent, the means of their own disinfection; hence, some of these are endowed with deodorizing as well as antiseptic properties.

We have already given at length the properties of chlorine. *Carbonic acid gas* is another of those antiseptic agents which will occupy our attention. It exists in the atmosphere as a product of combustion, and of the respiration of animals; it is a result, also, of the slow decomposition of most vegetable substances, and is evolved in great quantities from the ground in volcanic countries. In the formation of sugar it is produced in abundance, along with alcohol.

For the purpose of the chemist, it is generally prepared by decomposing marble by means of some stronger acid. From its cheapness and solubility of the residual salts, muriatic acid is generally employed.

The properties of carbonic acid are very remarkable; it is perfectly colorless and invisible; it is irrespirable, producing, when an attempt is made to breathe it, violent spasms of the glottis. If it be respired mixed with air, even in the proportion of one to ten, it gradually produces stupor and death, acting as a narcotic poison. Hence, when disengaged in large quantities, whether by natural operations or in process of manufacture, it accumulates in all cavities within its reach; and may cause fatal accidents to animals who enter unadvisedly.

Carbonic acid does not support combustion; a taper plunged into a jar full of the gas is instantly extinguished. Carbonic acid is also a check on putrefaction, and arrests decay.

SULPHUROUS ACID.

Sulphurous acid exists at ordinary temperature and pressure in the gaseous form; it is one, however, of the most liquified gases. It is produced always when sulphur burns, either in air or in pure oxygen; sulphur not being capable of passing directly to a higher degree of oxydation. In the burning of sulphur, the volume of sulphurous acid gas formed is exactly equal to the amount of oxygen consumed. Sulphurous acid gas may also be

simply prepared by heating three parts of flowers of sulphur with four of peroxide of manganese. The reaction is very simple; one part of the sulphur uniting with the metal, and another with the oxygen, form sulphuret of manganese and sulphurous acid. Another and quicker way to obtain this gas in small quantities, is to decompose a solution of hyposulphate of soda by adding muriatic acid to it, so as to liberate the hyposulphurous acid which immediately decomposes into sulphur and sulphurous acid.

Sulphurous acid is absorbed by water. It is colorless and transparent, possessing an odor peculiarly irritating, (the smell of burning sulphur,) and cannot be breathed. It is not combustible, nor does it support combustion. Water dissolves about thirty-seven times its volume of sulphurous acid. The solution possesses the properties of the gas in a very high degree, and bleaches vegetable colors with great power; when kept for some time it gradually absorbs oxygen, and the sulphurous becomes changed into sulphuric acid. The sulphuric acid is one of the feeblest acids, and is expelled from its combinations by almost all but the carbonic acid.

As has been demonstrated, all these gases are absorbed by water, and a saturated solution possesses the properties of the gases themselves. Some manufacturers, taking as a basis the antiseptic properties of carbonic acid gas, have brought before the public a class of metallic goods styled self-embalming caskets. Theoretically, the principle is good; but the requirements of its practical usefulness are so numerous that the simple application of the gas outside of the body will, in a great majority of cases, prove ineffectual.

The caskets are provided, on the under part of the lid, with a receptacle, into which is introduced, through a vent hole in the lid, some marble dust and sulphuric acid; immediately upon the mixture of these two substances, carbonic acid is generated, which, being heavier than air, falls to the bottom of the casket, and displacing the air contained in the casket, drives it out, by means of its superior density, through the vent hole purposely left open in the lid of the casket. After the space of from ten to fifteen minutes, which is generally sufficient for the gas to replace the atmosphere contained inside the casket, the vent hole is closed with a rubber cork, fitting tightly, and the process of

preservation thus ends. As we have stated before, the principle is good, but the practical result is very seldom satisfactory.

This generation of carbonic acid gas in an air-tight metallic casket, is a good auxiliary to the preservation of a body after this same body has been properly embalmed, inasmuch as it destroys effectually the oxygenation of the corpse by suppressing the interior atmosphere. But the circumstances, morbid or otherwise, which modify the preservation of a body under different conditions, make it impossible to depend solely upon that means as being certain and efficacious.

EMBALMING PROCESSES.

For chemical embalming, it is well known to those having experience as undertakers and embalmers, that in order to successfully perform this kind of work, it requires knowledge as well as experience. The various circumstances encountered necessarily govern the work. In the writers experience, he finds that when difficult and obstinate cases are to be retained for some length of time (especially in warm weather) it will be necessary to complete the work with care. A very important matter in this work is to renovate the stomach thoroughly; then, with simple instruments similar to an aspirator needle or trocar, give vent to the gases and thus expell them from the cavities of the system; Then with pump, draw off or force out the fluids and gases from the organs of circulation, and in this manner disinfect the body as far as possible. Elevate the head and shoulders for the purpose of letting the inky fluid gravitate from the cappillary system of the face, to the large vessels of the chest or thorax. This will renew the life's characteristics in a remarkable and satisfactory manner, if the gases be properly removed.

A simple method of disposing of the gastric juice of the stomach is to inject into the nose or mouth *one* or *two ounces of an aqueous solution* of *any powerful antiseptic*, similar to those mentioned in this article, and after a few moments carry the head off the bed, and, by gently pressing the stomach, empty its contents. This will prevent further difficulty from purging, if refilled with the solution and carefully sealed. Insert an instru-

ment into the trachea, and thus give vent to the gases in the lungs, and inject full of the solution. In the same manner dispose of the gases, from the thorax and fill with solution; also the abdominal cavities, by completing this, it will preserve the viscera. The re-agents mentioned below render the albumenoids material, incapable of putrefaction, by the impervious nature of the compounds it forms of all substances that have protein for their base, as the tissues readily absorb the preserving solution after being prepared as mentioned above.

This unites the antiseptic and deodorizing agent with the very substances that it is necessary to render inactive in order to successfully retain the remains of deceased persons.

DEODORIZING AGENTS.

The following are very good antiseptics and deodorizing agents: *Chloride of zinc*, *corrosive sublimate*, *hyposulphite*, *oxmuriate* of *mercury*, *carbolic acid*, *bicarbonate* of *potassa*, and *aqueous solution* of *alumina*. The two latter may be rendered more subservient by combining them, with the higher oxides. The metallic salts are much the best for chemical embalming if properly used. The remains of drowned persons may be prepared in the manner as above, with no small degree of success as giving to the gases, and freely applying antiseptics and deodorizing agents will readily correct, to a great extent, the difficulties thus encountered by this process. We have removed the most destructive fluids, or effected a combination with them, thus preventing the fermenting process and dispersing the gases, rendering the body absolutely free from those disagreeable and noxious odors which are termed phosphuretted and sulphuretted hydrogen gases, as well as low types or germs of disease, while the life's characteristics in this state of preservation invaribly present a most pleasant appearance, allaying all natural repugnance to the dead, as they seem so natural and life like, and remain in this state of preservation for a great length of time, or in transit, or various changes of atmosphere, while this manner of operation is simple and without complication, affording appropriate means that undertakers may apply successfully and save themselves annoyance, time, labor and expense, by a little practice and observing closely the directions herein given.

The enlightenment of the public demands more attention to these important matters, as there is no necessity for the untimely

and indecent burial of the loved but unfortunate victims of mortality, when due observance is given to the progress of art in modern science. To successfully retain the dead for such a period of time as will enable the bereaved friends to make such arrangements for burial as the occasion may require, without the necessity of mutilating the body in the horrible manner that has been practised in many instances, will meet the approbation of a grateful public.

Scientific research has defined and established those fixed laws of nature, with that precision whereby organic matters may be traced to their simple elements. We will herein endeavor to very briefly trace, as far as possible the chemical changes that are observed in dead animal matter. We assert that in the majority of cases (with a given temperature maintained) the first described subject will be, the first to become an uncontrollable mass from the agents of putrefaction: first, simply by the abundance of those fluids contained in subjects that immediately become active agents of dissolution, while such agents have been completely exhausted by the disease of the second.

The apparent healthy condition of the flesh after death is produced by the favorable temperature that is maintained, dryness of the atmosphere, etc, together with the general favorable conditions of the subject, which will render the preservation of such remains quite perfect, in some instances for a surprisingly long time. It is shown that disease of long standing completely exhausts the vital fluids before death, especially when the functions of the body have failed to produce the necessary nutrition. Thus it will be observed that the process of decomposition is very different than when the system is full of albumenoids and watery fluids, notwithstanding the tissues may have been seized upon by putridity before death. With consumptives, the disease reduces the flesh to dry parchment, or nearly so, leaving but a very small portion of water in the system. Hence, as putrefaction is impossible in the absence of moisture, and the active agent albumen, equally reduced, decomposition of such substances that remain ensues only by a process of decay, slow combustion or oxidation, the slowly uniting of oxygen with the substance. In this the constituent parts of the animal tissues break up into simpler compounds, by the chemical changes that nature produces, and differs from other forms of putrefaction

only, by the length of time employed. In cases like typhoid fever, the flesh, after death, assumes more of a putrid and slough-ing condition, as the fluids are not so completely exhausted as in the former disease, thus leaving more of the active agents in the body for its immediate destruction.

When death is the result of a putrid malady, putrefaction be-gins almost immediately when the body grows cold; its effects are noticeable much sooner when the atmosphere is warm. In general, in our climate here, the work of decomposition becomes evident after from thirty five to forty hours. Its first effects are noticeable on the skin of the stomach; this takes on a greenish discoloration, which soon spreads and covers the whole surface of the body; at the same time everything is seized upon by what is termed putridity; the moist parts soften and decay; little by little the flesh sinks and grows watery, and is thus carried away or burned up by the air's oxygen.

And now, we would impress your mind with the fact that the moment of the appearance of putrefaction absolutely varies with the degree of outward temperature, the causes of death, and the general condition of the remains, and just in accordance to the quantity of fluids remaining in the system. The degree of diffi-culty in retaining the life's characteristics are encountered, *first*, because of the albumenoids, the active agents of putrefaction; *second*, the large per cent. of water they contain, hence we have the necessary mobility of putrefaction, and the very substances that are most prone to the active ferments, united with the agents of disorganization, vibrois and bacteria, or rather the germs of thread-like corpuscles which penetrates the skin and wind their way through the ducts into the vessels of circulation which seem to conduct the rabid element to every structure. The living germs that collect on the surface of the body, and in the digestive canal, develop, multiply, pierce into all the points of the organism, and produce in it a complete separation of all the tissues and humors.

When persons have been killed suddenly, there being no disease to tamper with the functions of the body, the process of nutrition would be complete until the very moment the vitality is removed; hence the supply of fuel for this fire of dissolution. The corruption of these animal matters is not more possible than the fermentive action of gluten in grape juice, and precisely the

same. When these animal matters maintain a high temperature the products formed are said to be destructive distillation.

Many cases are recorded of similar stages of decomposition, which is an apparent spontaneous combustion, renewing the normal temperature of life, many times giving flushness to the cheeks, and thus appearing to have life renewed, notwithstanding the body had been cold for many hours previous to this phenomenon taking place, the result of a peculiar chemical action. But these instances seldom or never occur, while the difficulty encountered is, in completely reducing the heat from the bodies of those persons killed by accident, which fact renders the successful preservation of such remains for any length of time utterly impossible, as the fetid gases are evolved in such great abundance as to literally cook the flesh and escape into the air. Developed in the cadaverous odor, a pungent and ammoniacal stench, except there be prompt application of some powerful chemical re-agent, with which the organized material may enter into combination and thus overcome the evil tendencies of the affinities of its elements.

EMBALMING AND PRESERVATION OF BODIES.

The embalming of bodies, such as it was practiced years ago, and even to the present day in some parts of Europe, had for a basis the property of *tannin*, to form with animal substances insoluble compounds not affected by putrefaction; but the systems which Chaussier and Gannal brought forth, have rendered the use of tannin as an antiseptic agent, employed, *per se*, an obselete feature in embalming. This process of Chaussier, skilfully modified by Boudet, was as follows:

The viscera of the body and the brain were removed and preserved separately. The cavities left by the removal of these organs was filled with tow or cotton, so compressed as to prevent the sinking of those parts of the body.

While these operations were being performed, the body was plunged several times alternately in a bath of *pure alcohol*, and in one of *alcohol saturated with corrosive sublimate* after incisions inherent to the operation had been closed by proper sutures.

The body was laid in a wooden trough and completely immersed in a watery solution of corrosive sublimate. After three months of maceration the body was taken out, suspended horizontally on a network of strong linen bandages in a well-ventilated place, and left to dry until completely desiccated. If necessary, the sides of the body were padded by some new addition of tow in the interior, to avoid any deformation. This process has, among other advantages upon the older ones, that of keeping the body free from all external envelope which might hide it from sight.

But this method is not free from many objectionable points. In the *first* place it requires a large quantity of a substance high in price, and of rather dangerous manipulation; *secondly*, the operation is long, tedious and difficult; and *last*, the mutilation of the body strikes the relatives and friends with an unconquerable feeling of disgust and repugnance.

The process of Gannal is founded upon the property of alumina to form an imputrescible compound with the pre existing matter contained in all animal tissues. Mr. Gannal gives to the product of this combination the name of *geline*, because when submitted to the action of boiling water it forms *gelatine*. The embalming of bodies by this means is performed not only without any danger to the operator, but also at a small cost, as the substance employed does not command a high price. The time required by the operation is comparatively of short duration, as a simple injection of the arterial system and a short maceration are substituted to the removal of the viscera and the numerous incisions of the preceding mode of preservation. Moreover, the tissues by this process preserve their specific color and elasticity. This process, practically employed, consists in injecting through one of the carotid arteries a certain amount of aqueous solution of sulphate of alumina. This injection is followed for two or three days by a maceration of the whole body in the same liquid.

In the competitive experiments, which took place about twenty years ago, in the presence of a committee of eminent physicians, in Paris, France, Mr. Gannal is said to have made use of an injecting solution composed of equal parts of sulphate and chloride of alumina at a density of 34°. Those who entered the list against Mr. Gannal made use of: 1st, Mr. Dupre—carbonic and sulphurous acid. 2d, Mr. Sucquet—introducing in the arterial system, in the same manner as Mr. Gannal, a solution of chlo-

ride of zinc, marking 43° F. It must be remembered here that the second was the successful competitor. For simply preserving anatomical preparations, Mr. Sucquet uses a concentrated solution of hyposulphite of soda, and the solution of chloride of zinc, as given above, for the preservation of bodies.

It has been said, by different authors, that it was to the presence of arsenic in the liquids used by Mr. Gannal that this gentleman owed his numerous successes afterwards in the preservation of bodies. It is, however, forbidden in France to use arsenic for the embalming of bodies, although this substance forms the basis of several preparations employed in preserving specimens of natural history. The arsenical soap of Becoeur is extensively used for that purpose. It is also by means of arseniated alcohol, (alcohol in which arsenious acid has been macerated for several months,) that insects are preserved in their normal integrity.

Process of Dr. Franchina.—This process of embalming consists in injecting in the crural arteries one gallon and a half, or two gallons, according to circumstances, of the following solution: *Two pounds of arsenic in ten pints of distilled water, or in brandy.* It is evident that a greater part of the arsenic injected is held in suspension in the liquid, for in the above preparations it cannot be entirely dissolved. According to the authority of different writers, bodies thus treated can be preserved indefinitely, but they desiccate in a rather short time.

THE PRESERVATION OF MEAT BY CARBONIC ACID

Since 1874, when Professor Kolbe, of Leipsic, first published his results on the antiseptic action of salicylic acid, he has made many efforts to apply this acid to the preservation of meat, but he has invariably found that after the lapse of a few days an unpleasant flavor has been developed, which is not that of putridity. If putrid changes be noticed, it is a sign that salicylic acid is in insufficient quantity, for where it has turned putrid the meat is found to be no longer acid, but alkaline. This leads to the assumption that meat is protected from change by acids, even by gases of that kind; and in fact it was noticed that beef—from 2 to 5 kilos being taken—when placed in an earthen vessel and loosely covered with a wooden cover, was long preserved from putridity if the bottom of the vessel contained some hydrochloric acid, nitric acid, or aqueous sulphurous acid. The meat, how-

ever, no longer had the taste of fresh meat, but of such as had long lain in ice. Experiments were therefore made with carbonic acid, and these proved highly successful. The meat was placed in a cylinder of metal plate, and suspended from a rod which crossed the upper part and the lower part. A small tube serves to admit a current of carbonic acid from a Kipp's apparatus. The lid, which rested in a circular trough of glycerine, was traversed by a similar tube in its center, and both tubes could be closed with India rubber tubing and screw taps as soon as sufficient carbonic gas had traversed the apparatus. At the end of seven, fourteen, and twenty-one days it was found that the meat was still quite good, and the soup prepared from it was in every respect excellent. At the end of the fourth or fifth week the meat thus preserved in the gas was still quite free from all putridity; but the broth prepared from it no longer tasted so well as fresh soup. The experiments were not extended over a longer time. Carbonic acid is thus shown to be an excellent means of preserving beef from putridity and of causing it to retain its good taste for several weeks. Mutton does not preserve so well. In eight days it had become putrid; and veal is by no means so well preserved as beef. The comportment of beef in an atmosphere of carbonic acid, to which carbonic oxide has been added, is curious. A number of cylinders were filled in the usual way with such a mixture and opened at the end of two or three weeks; in each case the flesh had the smell and taste of good, pure meat, but it was not of the gray color which meat preserved in carbonic acid gas gradually takes, but appeared in the interior, as well as on the outside, of a bright flesh-red color, and on the surface here and there, there were white round masses of fungoid growth of the size of a 20-pfenning piece, which were removed with the slightest rubbing. The flesh lying just below these was found to have the same bright red color as that already described. Meat which had been for three weeks in such a gas mixture gave a broth which, in good taste and freshness, could hardly be distinguished from freshly made soup; and the boiled meats could not be distinguished either in appearance or taste. The property of carbonic acid to preserve meat suggests a use for the large supplies of this gas evolved from the earth in many localities. And it is as interesting to determine in how far the gas could be of service as an antiseptic during surgical operations.

We have already spoken of the employ of *chloride of zinc* in the preservation of bodies in connection with the system of which Mr. Sucquet was the founder. In 1840 an English chemist, Wm. Burnett, patented a new antiseptic fluid for the preservation of animal and vegetable substances. In the solution, which is composed of *chloride of zinc 15 ounces*, *distilled water 1½ gallons*, the substances to be preserved are immersed for two or three days, and then left to dry by the action of the atmosphere.

The *salts of iron*, especially the *persulphate* of *iron*, have been ranked among the best anti-putrids.

Dr. Dusourd has accomplished the perfect preservation of animal substances by their complete saturation with a ferruginous syrup, of which he is the inventor. He has even proposed it, as a certain and cheap means of embalming bodies.

Sulphate of alumina is frequently employed for the preservation of bodies; but this salt being always acid, Dr. Homolle saturates its solution with *oxide of zinc* and thus obtains a compound forming a *sulphate of zinc and alumina*, which is employed with advantage for the purpose named.

Acids sometimes forms the basis of antiputrid compounds, for instance, it is admitted that *acetic acid* weakened (vinegar) has been for a long time an agent of preservation of alimentary animal substances.

The *Alkalies* also, under certain peculiar conditions, are useful in transforming the fat of animal substances into soap, and thus facilitate their desiccation. The use of *natron* (carbonate of soda) anterior to that of *asphaltum*, in embalming, as practiced by the Guanches and Egyptians, must certainly have been employed for no other object.

Another embalming process, patented in New Jersey in 1880, consisted in removing the brains and intestines, filling the cavities with cotton, saturated with a compound of *saltpetre*, *sulphurous acid gas* and *water*, then closing the cavities, subjecting the body to the action of *sulphurous acid gas*, and finally steeping the body in said compound.

The *German process* of preservation, especially that of the celebrated Dr. Wickersheimer, which is very good, contains as follows: *3,000 grammes of boiling distilled water, 100 grammes alum, 25 grammes table salt, 12 grammes saltpetre, 60 grammes sulphate of potash, and 20 grammes arsenious acid*, mixed to-

gether while boiling; this solution is cooled off and filtered. To *ten liters* of that solution add *four liters of glycerine*, and *one liter of methylalcohol*. Also another solution by the same gentleman: *Borax, 100 parts; sulphate of potassium, 40 parts; sodium chloride, 50 parts; nitrate of potassium, 30 parts; carbonate of potassium, 92 parts; arsenious acid, 20 parts; glycerine, 3,000 parts; methylalcohol, 500 parts; and distilled water, 6,200 parts.*

WICHERSHEIMER'S PRESERVING FLUID.

The following is said to be the formulæ now adopted by prominent manufacturers in Berlin for this liquid, according as it is to be used for injecting or immersing bodies:

	For Injecting.	For Immersing.
Arsenious acid	16 grammes.	12 grammes.
Sodium chloride	80 "	60 "
Potassium sulphate	200 "	150 "
Potassium nitrate	25 "	18 "
Potassium carbonate	10 "	15 "
Water	20 liters.	10 liters.
Glycerine	4 "	4 "
Wood naphtha	¾ liter.	¾ liter.

Hager suggests the following as a substitute for Wickersheimer's preparation:

Salicylic acid	4 drachms.
Boracic acid	5 "
Potassium carbonate	1 drachm.
Dissolved in hot water	12½ ounces.
Glycerine	5 "

Then add:

Oil cinnamon, oil cloves, each three drachms,
dissolved in alcohol.....12½ ounces.

The latter fluid is not poisonous, and possesses the desirable property of acting as an antiseptic, and is possessed of a pleasant odor. The borosalicylate may be used in connection with other solvents if desired.

The following two modifications of the fluid are now in use, the former for injections and the latter for steeping objects to be preserved:

Arsenious acid.....	16 grammes.	12 grammes.
Sodium chloride.	80 "	60 "
Potassium sulphate.....	200 "	150 "
Potassium nitrate	25 "	18 "
Potassium carbonate.....	20 "	15 "
Water.....	10 liters.	10 liters.
Glycerine.....	4 "	4 "
Common methylic alcohol	¾ liter.	½ liter.

The celebrated Dr. Pousino, of Macao, used the following solution for embalming bodies: *Boil in 10 gallons of distilled water, 1 pound alum, 8 ounces of common salt, 10 ounces of saltpetre, 18 ounces nitrate of potash, 8 ounces of white arsenic, 2 ounces chloride of zinc. 8 ounces corrosive sublimate, 8 ounces camphor, 2 gallons glycerine and 1½ gallons alcohol.* That same gentleman recommends also a solution of *alum, tannic acid* and *corrosive sublimate* for external submersion of the body.

The dead bodies of human beings by the above processes are claimed to fully retain their form, color and flexibility. Even after a period of years such bodies may be dissected for purposes of science and medical jurisprudence. Decay and the offensive smell of decay are completely prevented. Preparations made of the several parts, such as natural skeletons, lungs, etc., retain their softness and pliability. In Pittsburgh, Pa., a solution of *one pound of arsenite of soda in one gallon of water* has been used with perfect success for preserving bodies; injected in the arteries.

The different modes of preservation which have successively been presented to the reader, are all well adapted to the prevention of putrid decay of animal substances; but, as Decanu remarks, these means, besides being more or less expensive, necessitating more or less time in their execution, etc., they cannot be applied with equal success in the preservation of all of the animal substances. We will here, for the benefit of our professionals who may desire to thoroughly understand the qualities and specific properties of the chemicals they are using, give a statement of their particular effects upon the various parts of the organism:

Tasmin, or *tannic acid*, preserves admirably the skin; it does not seem to have an effect on muscular tissue.

Concentrated alcohol contracts those parts which are essentially cartilaginous,—therefore the necessity to use first weak, and afterwards to replace it with strong alcohol to prevent their shrinking and difformation. It is said that a slight addition of ammonia mitigates this baneful effect of alcohol, but still it will destroy in a short time the natural color of animal matter. Again, an addition of chlorydric acid may obviate this inconvenience, but it may change a great deal the appearance of the body.

Bichloride of mercury causes the tissues to skrink and harden and gives them a brown tinge, except the muscles, which are whitened thereby. It is an excellent preservative when it is not a matter of importance to keep the natural aspect of the specimens; it becomes, therefore, almost useless when these preparations are to retain their natural integrity.

Alum is a good agent of preservation for the membraneous parts of the body, but it deposits sediments which tend to the discoloration of the parts effected.

Persulphate of iron, according to the statement of several English writers, attacks the bones.

The *chloride of zinc*, which decomposes the calcareous matter of the bones, is only useful in the preservation of the fibrinous and cartilaginous parts.

Acids in general are good preservatives of matters containing fat, but they corrode tissues and alter their color; also destroying the calcareous parts of the bones.

The *alkalies* are, properly speaking, but preparatory means of preservation, having no specific properties as direct agents.

Essential oils are good agents of preservation, but they dissolve the fatty parts, which may be essential to preserve; they are not, therefore, to be employed when this particular action is to be avoided.

ANTISEPTIC SUBSTANCES.

Miquel has recently published a memoir on antiseptic substances and their action, and his results will be studied with interest. Antiseptic bodies are roughly classified as follows:

1st class.—"Generally antiseptic" bodies, of which from 0·01 gramme to 0·10 gramme suffices to preserve one liter of broth from putrefaction. This class includes peroxide of hydrogen and bichloride of mercury. 2d class.—"Very powerful antiseptics," or bodies of which from 0·10 gramme to 1·0 gramme is re-

quired to preserve one liter of broth. Iodine, chloride of gold, tetrachloride of platinum, hydrocyanic (prussic) acid, and bromine come under this heading. 3d class.—"Powerful antiseptics," of which from 1·0 to 5·0 grammes are required. Chloroform, potassium bichromate, ammonia, thymol, phenol, permanganate of potassium, nitrate of lead, alum. 4th class.—"Moderately antiseptic" bodies, from 5 to 20 grammes being required. Hydrobromate of quinine, white arsenic, sulphate of strychnia, boric acid, arsenite of soda, hydrate of chloral, salicylate of soda, caustic soda. 5th class.—"Slightly antiseptic substances," from 20 to 100 grammes being required to preserve the liter of broth. Borate of soda, hydrochlorate of morphia, alcohol. 6th class, or "Very slightly antiseptic substances," includes those bodies of which from 100 grammes to 300 grammes are required; and under this heading M. Miquel mentions iodide of potassium, common salt, glycerine, ammonium sulphate, and sodium hyposulphite. Substances, such as sugar, which must be present in a much larger proportion in order to exercise a preservative action, are placed outside the category of antiseptics.

Bacterial germs and adult bacteria were added to broth, and it was found by experiment that the following quantities of the various antiseptic substances added to one liter served to prevent the rejuvenescence of the bacterial organisms.

Class 1.

Peroxide of hydrogen	0·5 gramme.
Bichloride of mercury	0·7 "

Class 2.

Iodine	0·25 gramme.
Chloride of gold	0·25 "
Tetrachloride of platinum	0 30 "
Hydrocyanic acid	0·40 "
Bromine	0·60 "

Class 3.

Chloroform	1·0 to 2·0 grammes.
Patassium bichromate	1·2 "
Ammonia	1·4 "
Thymol	2·0 "
Phenol	3·2 "
Permanganate of potassium	3·5 "
Nitrate of lead	3·6 "
Alum	4·5 "

Class 4.

Hydrobromate of quinine	5·5	grammes.
White arsenic	6·0	"
Sulphate of strychnia	7·0	"
Boric acid	7·5	"
Arsenite of sodium	9·0	"
Hydrate of chloral	9·3	"
Salicylate of soda	10·0	"
Caustic soda	18·0	"

Class 5.

Borate of soda	70·0	grammes.
Hydrochlorate of morphia	75·6	"
Alcohol	95·0	"

Class 6.

Iodide of potassium	150·0	grammes.
Common salt	165·0	"
Glycerine	225·0	"
Sulphate of ammonia	250·0	"
Hyposulphite of soda	275·0	"

Some sodium salts—as, for example, the sulphate—are remarkably inefficient, a dose of 500 grammes being insufficient to prevent the germination of the bacteria. It may, perhaps, be fairly assumed that the broth fairly corresponds with a weak gelatinous solution as regards its capability of supporting bacterial life.

Action of Borax on the Animal Organism.—Animalcules placed in a drop of water, to which is added a concentrated solution of borax, have their movements arrested and die, while the sarcode of the infusoria coagulates.

The larva of frogs, rendered transparent by being kept in prolonged obscurity, present convulsive contraction of the muscular fibres of the tail when placed in a solution of borax, and the circulation so easy to observe in these animals is lessened little by little, and the plasma of the blood coagulates, killing the animal in less than an hour.

A pound of beef placed in a concentrated solution of borax in an hermetically-sealed tin box, gave off a disagreeable odor, which had nothing in common with that of putrefaction. After more than a year and a half, notwithstanding the heat of the summers of 1873 and 1874, this meat had not the least odor of putrefaction, and appeared like fresh meat. This same meat exposed to the air did not putrefy.

These same experiments repeated with other meats gave similar results. The *sui generis* odor possessed by meat which has been preserved for a certain length of time in a borax solution seems due to the decomposition of material resulting from the metamorphoses of substances composing the muscular fibre or intermuscular plasma.

A concentrated solution of borax can be utilized for the preservation of anatomical preparations: a great economy over the use of alcohol would result from its employment.

EMBALMING BODIES.

The board generally employed to lay the body on, while the operation of embalming is being performed, resembles an ordinary cooling board, with an adjustable head rest; it is also provided with a rim extending all around, and raised about an inch above the level of the board; this rim stops at the foot, where the board remains open in all its width. There are also longitudinal grooves running the full length of the board. The usefulness of this arrangement is obvious, as the liquids which are used during the washing and embalming of the body run down the grooves—the board being raised at the head, about one foot during the operation—and can easily be collected in a pail placed under the foot of the board. This will do away with soiling the floor or carpet, as is often the case with the common board in use. The rim around the board will also prevent any liquid from dripping over the sides, and will save a great deal of annoyance and trouble.

The greatest of precaution must be used by the operator; all useless and unnecessary talk must be avoided while at work; the mind must be concentrated upon the work in hand. The knives, needles and other instruments must be carefully laid away on a stand within easy reach of the operator, and not be left lying about the board, under sponges, towels, etc.; these might be grasped thoughtlessly, and in doing so a gash might be inflicted which, if not fatal, would certainly prove very serious.

Before commencing the operation, and after the body has been thoroughly cleansed with soap and water, let the operator anoint and rub his hands with either *lard* or *sweet oil;* not so much so as to soil any article used, but let a vigorous rubbing force the oil into the pores of the skin, until the hands are almost dry.

The *eyes and mouth* being carefully closed by the usual means,

let the body be well saturated with the alum or bleaching solution as mentioned, in the chapter of preserving dead bodies.

A cloth moistened with this solution may be laid on the face, and remain while the operation is being performed. The solution should not be wiped off, but it should be allowed to dry on the body; the water will evaporate and leave behind it, a thin coating of the salts, which, by penetrating the pores of the skin, will render it imputrescible.

Next, an incision about *five* or *six inches in length* is cut *transversely* from *right to left* in the *abdominal region*, *over* the *stomach*, about *one inch* in a *line* below the *curvature* of the *lower ribs*. Through this opening is revealed the *stomach* on the *right*, the *liver* and *gall-bladder* on the *left*, the *transverse arch* of the *colon* in *front*, and *below*, the *smaller intestines*.

If the *stomach* is distended with food or gas, it must in all cases be emptied of its contents and injected. For this purpose, puncture the walls of the stomach on the side exposed to view, and passing the left hand gently between that organ and the ribs, press down, so as to force the contents out and through the opening made. Then after the stomach is completely emptied, inject the embalming fluid.

The *small intestines* must then be gently and carefully drawn out, and allowed to lay on the right side of the abdomen; this will reveal in the abdominal region a cavity, which may, or may not be filled with serum, according to circumstances. At any rate, should there be any liquid, it must be carefully pumped out, or sponged off until perfectly dry.

The *cavity* is then to be sprinkled heavily with *tannic acid*. The small intestines must then and before being replaced, be next attended to. If inflated with nothing but gas, a simple puncture at different points, so as to favor the escape of the gas, and a moderate injection through the aperture, will suffice.

If however, the intestine should be found congested with blood or some other substance, the contents must be emptied by the following method: Seize firmly, between the two fore-fingers of the left hand the intestine, at the lowest point you can reach, and with the right hand draw the intestine through the fingers of the left; this will have the effect of forcing the contents of the intestine forward in front of the fingers of the left hand. After the matter has so accumulated that the progress is im-

peded, the *intestine must be cut*, the *matter extracted*, the part which has thus been emptied, *injected* with the *embalming fluid* and then tied up. This operation must be repeated, until the whole of the intestines, small and large, have been emptied and injected, and then the whole is to be replaced into the cavity.

About four ounces of embalming fluid must be poured over the intestines, and the wound neatly sewed together.

It may be found necessary before closing the opening, to lay a thickness of cotton batting over the bowels and under the walls of the abdomen.

Should the *lungs* be *congested with blood*, they must be *emptied.* This object may be attained by pressing upon the lower part of the thorax, which will have the effect of forcing the blood out through the nostrils and mouth. The utmost caution must be used in perforating the diaphragm, as some of the arteries might be wounded, by a careless use of the knife.

The above operation may be performed, before closing the wound in the abdomen, or replacing the intestine into the cavity, as it will then leave more room to collect the fluid which may escape from the lungs.

The *lungs* should *in all cases* be *well injected* either *through* the *trachea*, or by the process given above. The *air passages* must be *carefully stopped* with cotton. The mouth being closed, the nostrils are about the only air passages which require the attention of the operator.

The *eyes* after a few days, are liable to sink in the sockets, which gives the body an unnatural appearance. Mr. John C. Rulon of Philadelphia, Pa., has invented a wax shell, which after being introduced under the eye-lids prevents the sinking of the eyes.

The arterial system is to be injected, and next requires attention. Before commencing to inject the arteries, the jugular vein on the left side of the neck must be punctured so as to allow the blood to escape. In some subjects the flow of blood will be very copious, in which instance the jugular veins must be opened on both sides of the neck; at other times the flow of blood will be very limited, and even the opening of the vein has sometimes been found quite unnecessary.

The *femoral artery* is the vessel generally chosen for injecting, at a point below the arch, about eight inches from and be-

low pouparts ligament. After the artery has been raised, a small incision is punctured into the coat of the artery, large enough to admit the nozzle of the injector, and the canula is carefully pushed upwards into it as far as its length will allow; the artery is then safely and firmly fastened around it, and everything is then ready for injecting.

On the mode of *injecting depends*, in a great measure, the success of the operation. With some of the instruments now employed, the pressure of the injecting fluid is so strong and sudden as in many instances, to rupture the walls of the arteries at some weak point, and fill the cavities of the *thorax* and *abdomen*; sometimes even the liquid has been forced in, with such force, and in such quantities, as to burst the arteries, and, after filling the chest, to pour out in a stream from the mouth and nostrils.

In the above instances, it stands to reason, that neither the arterial nor venous systems have been properly injected.

The *injection* should be performed in a *slow, regular manner.* After a quart of the fluid has been injected, the operation should be suspended for about ten minutes, after which it should be renewed in the same manner, until about a gallon, or a gallon and a half have been injected. Sometimes the quantity injected need not be so great; this depends entirely on the build of the dead body; in the case of a person much emaciated by long illness, use about half that quantity; or if the subject be a child, less still is required.

The *jugular veins* must be kept *open* so long as the *flow* of *blood* continues, but they must be closed as soon as the embalming fluid makes its appearance. The best manner of closing the veins is, by introducing into the jugulars a small pad of cotton, and neatly sewing up the opening.

It should be remembered that the cloth moistened with the solution for the face should be kept on, well saturated, while this operation is being performed, and even for a few hours after the body has been dressed.

A body prepared in this manner has been kept, in a wooden coffin, in a dark and moderately cool place, for nine months, without any perceptible change. After that time the shrinking of the tissues took place, and the body was slowly drying up, and being desiccated without in the least decaying or putrefying.

It will seem, that even after the arterial and venous systems

have been properly injected, there still remains a prolific source of putrefaction in the liquids contained in the intestines, and the thoracic viscera; for instance, the fæcal matter contained in the intestines, and the undigested food in the stomach at the time of death, must all be evacuated, and the organs containing them properly cleaned and injected, and unless this be done, fermentation will set in, and be followed by rapid decay of the surrounding tissues. It is true the arteries and veins extend their branches to all parts, and to every organ in the body, but it is also an undeniable fact, that the contents of those organs which are prone to putrefy will carry the infection to the vessels containg them. The stomach and bowels are emptied of their contents for the mere reason that these same contents are always undergoing a process of fermentation, which will generate into rapid decay and the emission of noxious gases.

In certain cases of consumption, the lungs are gangrenous and decayed long before death takes place; and it will then be found necessary to introduce through the trachea some antiseptic fluid which will stop the progress of decay.

Besides the knowledge of the information given, it will enable the embalmer to follow the workings of the embalming process in all its details, and enable him to discover the causes of failure in certain cases; also to use the proper means in the achievement of success.

ANOTHER PROCESS OF EMBALMING.

The following process is more laborious, and requires more time than the one already given, but at the same time, it is more complete and lasting, and when the operation is skilfully and properly performed, the body may be said, to be embalmed for an indefinite period of time. But to carry out this process to a successful issue, it will be found strictly necessary to study well, and bear in mind, all the details of the operation.

It would be impossible to omit any part of the process and still expect the same results, for, after repeated experiments and trials under favorable and adverse circumstances, the results have always proved to be the same. Still this process is regulated by the same laws, and governed by the same conditions which effect a body under all circumstances. An explanation of these conditions has already been given, and it will be found that a thorough knowledge of these will materially assist the operator in his work.

Let us suppose, for one moment, that a man entirely unacquainted with the causes which may effect the morbid conditions of the veins and arteries, goes recklessly on, and commences to inject some part of the circulating system; if that system is in a normal condition, the injection will prove successful; if not, the worst consequences may follow. How is he then to remedy his mistake? His very limited knowledge, if he has any, will be of no avail to him. It is in the lack of a sufficient understanding of the human organism that the cause of many failures is to be found. When the proper antiseptics are used, the fault does not lie in their inefficiency, but in the manner in which they have been employed.

It is unncessary to repeat here, what we have before stated, that in order to understand thoroughly the process of embalming, the operator must make himself familiar with the explanations already given, and also with those, which shall be found hereafter.

It will be seen in the following pages that the mode of treatment to which the body is subjected in this process, is entirely different from that which has already been given.

The completeness of this process will be readily understood after a careful study of its details, and if strictly followed in every particular will be found not only satisfactory in its results, but also lasting for an indefinite period of time.

It is well enough to say here, that a metallic casket is not required to assist in keeping the body after it has been treated according to the following method. Quite the reverse, a wooden casket will answer the purpose much better, as the body is rendered perfectly inaccessible to the attacks of the ambient atmosphere by the external covering which encases the body in its transparent and elastic coating, impervious alike to air and moisture.

The body should be placed upon a table about four feet high, and elevated nearly six inches at the head. It must be here borne in mind that, to perform the following operation successfully, the operator should be left alone to his work, in a room free from intrusion, where idle questioning from standers by, or the talk of the usual routine of business, will not disturb him. And as it may require some time to complete the work, it were better that the remains were brought to the undertaker's estab-

lishment, where there is generally, or ought to be, a room set apart for this branch of the business.

The body is first washed clean with soap and tepid water, so as to remove every particle of fat or greasy substance, which might obstruct the pores of the skin, and thereby prevent the salts contained in the bleaching lotion to penetrate the tissues and produce the desired effect. The body must then be thoroughly dried by means of clean towels, and be well saturated with the above lotion.

The body is to be kept constantly moist with the aforesaid, and as soon as evaporation has dried up the surface of the skin, a new application of the solution becomes necessary, in fact, the process should come as near complete immersion as possible. The eyes must be well closed. To avoid the sinking, which will disfigure the best prepared corpse, we use now wax shells to be inserted under the eyelids to keep them in place, the outside of the shell must be coated with white gum shellac, dissolved in alcohol. After the insertion of the shells thus coated, the lids are brought together, and held in place by the fingers. Shellac dries quick and in about five minutes time it will be found that the gum has acquired enough consistency to hold the lids together. As a matter of course, it will get harder in time, and prevent the lids from starting apart.

The operator will then cut a straight line through the skin with a scalpel, the line to extend from the superior part of the sternum, to the umbilical region. Another incision of the skin is to be made at right angles from the first, about six inches in length, and one inch below the lower bend of the last rib.

Then with the thumb and forefinger of the left hand, seize the skin firmly at a point where the two lines intersect each other, and with the scalpel held in the right hand, carefully separate the skin from the fascia underneath. This operation is repeated on the four sides, and the flaps of the skin turned over the sides of the body. This will leave exposed to view a diamond shaped opening of the epidermis, with its apex reaching above, to the superior portions of the sternum, and the lowest angle reaching to within two inches of the naval; the two lateral points extend on both sides of the body, from the region of the stomach to the liver, and almost immediately above the transverse arch of the colon.

To cut through the abdominal fascia, carefully puncture it above the stomach, so the opening will be large enough to admit the forefinger of the right hand being introduced through the opening; then holding the scalpel with its edge upward, the back resting along the extended forefinger, introduce both into the opening and cut from downward upward into the fascia of the abdomen in a straight line across from the stomach to the liver in a similar way to that above described for cutting through the skin. This last incision is to follow the same course as the one cut in the epidermis, and will extend from one to the other lateral angle of the diamond shaped opening in the skin. This opening will reveal the stomach on the left, the liver on the right, and the transverse arch of the colon immediately beneath.

Then another cleaving of the fascia is to be performed, downwards and in a similar manner, from the middle to the transverse opening, to within two inches of the naval; this last opening exposes the small intestines.

The reason why the cutting of the fascia of the abdomen should be performed in this manner, that is, with the scalpel being held edge upward along the extended forefinger is obvious; the forefinger in this case acts as a guide to the scalpel in dividing the tissues, and also protects the viscera from being wounded by the sharp point of the knife.

The abdominal viscera being thus exposed, the lungs, heart and other parts of the thoracic viscera must also be uncovered. For this purpose, and with the cartilage knife separate the ribs from the sternum about two inches on either side of the latter, commencing from the second rib down to the last one, and extending to the transverse opening made in the abdomen; it will be found that the ribs at that distance from the sternum are attached to it by a cartilage, which it is very easy to cut in children, harder in adults, and it may sometimes be indispensable to use a saw on old persons. This cutting through the ribs must be carefully performed, for fear of wounding some of the organs which lie immediately beneath and against the ribs.

The sternum being thus freed from the ribs, it can be turned back over and against the face, and will reveal through the opening thus made, the lungs, the heart, the arch of the aorta, etc.

The operator should use extreme caution, whilst performing this operation, as the jagged and sharp edges of the ribs might

cut through the skin and inflict a wound, should the hand be suddenly brought in contact with them. It is also necessary to enjoin again, forcibly the recommendation made before, of keeping the body well saturated with the lotion while the work is progressing.

The bowels must then be carefully displaced, and all fluid and serum found between or under the intestines be completely sponged out; the intestines must also be emptied of their contents by the process which has already been given in the first method of embalming; also the stomach, the gall bladder, all the organs in fact, which contain foreign elements prone to putrefy. The bladder can be emptied of the urine by means of a catheter, introduced into the urinary canal.

All of the organs which shall have been emptied of their contents, as also the intestines and the bladder, must be injected with the embalming fluid.

As to puncturing the different organs for the purpose of emptying their contents, the manner for doing so, has clearly been given in the former process for embalming bodies, but great care must always be used, so as not to perforate any of the vessels of the circulatory system.

The next step is to inject the arterial system. For this purpose a different point for injecting the system is selected from the one pointed out in the former process. By removing the small intestines out, and on the right side of the body the descending branch of the aorta is exposed to view. In its course downward, the aorta lies on the vertebral column to the left of the middle line, and terminates on the fourth lumbar vertebra, by dividing into the two common iliac arteries. The descending branch of the aorta is then punctured so as to admit the nozzle of the injector; this is introduced into the opening in an upward direction, and the walls of the artery are then tied firmly, but not so, as to cut through, around the nozzle. After the artery has been thus prepared, and before injecting, the vena cava must be perforated at a point corresponding with the incision practiced in the descending portion of the aorta where the nozzle of the injector is inserted.

The inferior *vena cava* ascends *along the front of the vertebral column*, and to the *right* of the *abdominal aorta*. The object of severing this vein is, to give the blood in the upper portions of

the body a means of escape, as the fluid is forced through and up the arteries of that part, and returning through the veins forces the blood through the opening.

After the upper portion of the body has been injected with about half a gallon of the embalming fluid, the nozzle of the injector must be reversed and the lower parts injected in a similar manner with about the same amount of fluid; the injection must then be stopped for the space of about three hours, and all the blood which may have escaped from the opening made in the vena cava into the cavity of the intestines must be sponged out, as it fills up the space left.

The mode of injecting is also of extreme importance. The injection should be done slowly and steadily, as a strong, sudden forcing up of the liquid into the arteries might occasion a rupture of their walls should some point be weakened from causes arising from previous sickness, or from lesions as described in a previous chapter.

The injection may then be renewed, and more liquid be injected, until a sufficient quantity has been used. As there are no rules laid down for the amonnt of liquid to be injected, it is left altogether to the discrimination and good judgement of the operator.

The bodies of children and old persons will require less liquid than adults up to the age of forty-five. The bodies of persons killed by accident or some sudden cause, will require a larger amount of liquid, than those of persons who are emaciated by long illness, as for instance consumption.

After the arterial and venous system have been thus completely injected, the intestines must be replaced in the abdominal cavity.

The brains must next be removed, and this operation is one, which requires extreme caution, as will be seen by the following explanation of the process:

The body is turned on the right side and by means of a trephine, a round hole is cut into the back of the skull, about two inches above the cerebellum; the piece of bone thus taken out is preserved, so as to be replaced into the opening after the operation is finished. Previous to cutting through the skull a small incision in the shape of a cross, about two inches in length each way must be cut into the skin. The object of this is, to leave

the bone denuded, after the skin has been detached from the bone, and also to bring the parts together by sewing after the brain has been removed.

Through the opening thus made in the skull, the brain, or the portion of it, which can be reached, is easily removed by means of a small slender spoon with a long handle, made for this purpose. The cavity thus made in the head is to be filled with the following:

Take *two gallons or more* of *water* and *saturate* with *alum*, as *much* as it *will dissolve*; next *mix* with *plaster of paris* to the consistency of *nery thin paste*, and fill the cavity of the brain; some cotton may then be introduced to keep the mixture inside; the round piece of bone cut from the skull is then replaced, the flaps of the cut in the skin brought together, and neatly sewed up. If this operation is carefully performed, the cuts thus made can not be perceived under the hair.

Great caution should be exercised, while removing the brain, in not wounding any of the veins and arteries which are inside that part of the skull, and with a little care, this can be easily avoided.

The body is then turned again on the back, in the former position and all the cavities in the thorax and the abdomen, between and under the intestines, the liver, the lungs and the heart, must be well cleaned and dried with a sponge of all liquid or serum that might be found. Pulverize some tannic acid into fine powder, and sprinkle heavily around and between the organs of the thorax and abdomen; the sternum is then replaced over the thoracic opening, the flaps of the skin temporarily brought back over the abdomen, and the body being enveloped in a sheet or some linen cloth, well saturated with the *lotion* for *the face*. The face, hands, feet, in fact every inch of the surface of the body, above and under, is to be covered with the cloth, tightly wrapped around it, and well saturated as above directed.

The body must be kept in this condition for about twelve hours, when the cloth is to be removed; the sternum is then raised again and the skin over the abdomen thrown back, the above named mixture of alum, etc., is then poured over the whole of the thoracic and abdominal viscera, being careful to fill completely all the interstices existing between and under the different organs and the intestines. This composition, or cement,

must be brought up to a level with the ribs in the thorax, and cover the viscera in the abdomen; after the cement is set or nearly so, sprinkle a plentiful quantity of powdered tannic acid on the top of it.

Then bring the sternum down to its proper place between the ribs, and also the internal fascia of the abdomen over the viscera; and last, the flaps of the skin are brought together and neatly sewed up, taking a stitch alternately under and above the skin. Should the mouth have a tendency to remain open, or the lips too far apart, fill the inside of the mouth between the cheeks and gums with cotton, well saturated with the fluid and use the above named cement as paste; it will give the body an appearance more natural and less emaciated. This rule ought to be applied in all cases: the friends and mourners of the family will always appreciate anything of the kind, which tends to beautify the remains and divest death of its hideousness.

The nostrils must also be filled with the same composition, after which, place some cotton wads saturated with embalming fluid, high up, so it can not be seen from outside.

After the body has been so far prepared, it remains to encase it into a transparent and elastic covering, which will prevent the attacks from the atmosphere, and at the same time, render the body impervious to moisture. For this purpose, procure some *fresh Canada balsam, perfectly colorless;* also a glass jar with large mouth; this jar should be large enough to hold twice the amount of Canada balsam on hand; bring the jar near the fire if it is in winter, and submit the balsam to a gentle heat until it is liquified; so soon as the balsam has attained the consistency of thin honey, add to it the same amount of the *best spirits of turpentine* that can be obtained, and stir with a glass rod, until the balsam and turpentine have been thoroughly mixed; then apply the mixture on the body by means of a camel's hair brush, very wide, in shape to that used for copying letters.

A single thin layer of this mixture is quite sufficient, and should be evenly applied to any part of the body, where the growth of hair is not sufficient to exclude the approach of the atmosphere. It will require but a very short time for this varnish to dry, and then the body will be ready for either burial in

a crypt, easy of access, or for transportation to any foreign country.

In the course of time, the organic tissues will dry and desiccate; the bony prominent parts of the joints may become more angulous, the skin may assume a slightly yellow tinge, but the features will always be natural and recognizable, the skin will never shrivel up and shrink back exposing the teeth, as is generally the case with the Egyptian mummies, and above all, putrefaction with all its repulsive hideous accessories will never take place, nor will noxious gases or offensive odors be emitted.

A wooden casket will also be found preferable to a metallic one, as the free admission of air will favor the drying up of the tissues and the absorption of whatever little moisture might find its way out.

Embalmers will find this process to be without any exception, the best method ever employed; bodies prepared as above, can be shipped to the most distant points across the seas, will keep well in any climate; or, can be preserved for an indefinite period of time in some vault, where the surviving members of the family can at any time obtain a vision of the body without having their sensibilities shocked by the horrible picture of slowly decomposing animal matter.

It must not be forgotten that, if the above process is slow, long and tedious, requiring a good deal of labor and delicate handling, the results obtained are equally important, and the compensation commensurate with the magnitude of the undertaking.

GRANNEL'S PROCESS OF EMBALMING WITH MODIFICATIONS.

The following process, which has been successfully employed in Europe especially in France and Italy for a long time, for embalming bodies and for the preservation of anatomical preparations, is still practiced extensively, owing to the cheapness of the materials used, and the simplicity of the modus operandi.

Lay the body on an inclined board, as described in a former chapter, and, after thoroughly cleansing with water and soap, saturate well with a concentrated *solution of alum*; the body should be kept well moistened with the solution in the same manner as above described, until the operation is completed.

Through an opening made in the skin of the abdomen, and immediately over the transverse part of the colon; the bowels and the stomach will then be revealed, which must be emptied

of their contents and properly cleansed, and injected with the preparation.

After the contents of the abdomen have thus been treated, the whole abdominal viscera is to be heavily sprinkled over, with tannic acid, until the acid forms a layer of about one-half inch in thickness between the bowels and the skin of the abdomen; the flaps of the skin are then brought together and neatly sewed up. Make an incision on the right basilic vein, and the blood in some cases, will issue very freely, and the flow of it must continue until the embalming fluid makes its appearance.

To inject the circulatory system, extend the left arm at a right angle with the body and open the axillary artery, about three inches from the arm pit. The axillary artery is a continuation of the sub clavian artery; it passes through the axilla or arm pit into the arm, and is called the axillary artery; that part of its continuation into the upper arm is called brachial artery, and in the fore arm, it divides into the radial and ulnar arteries, which are distributed to the hand and fingers.

Through the opening thus made in the axillary artery, two gallons of embalming fluid may be injected, slowly but steady, or such quantity as may be found necessary to completely fill the arterial and venous systems.

After the blood has ceased to flow from the opening in the basilic vein, the wounds must be sewed up, and the body annointed with the solution, is left to dry in a cool, well ventilated place.

The surface of the body, as also the face may be mottled in some places with white spots, but the skin will soon assume a uniform color, and the blotches will disappear.

After the solution on the body has become sufficiently dry, and has penetrated the pores of the skin, the excess of moisture must be wiped off, with a clean towel.

The nostrils should be hermetically sealed, by introducing into them some cotton, well saturated with gum shellac dissolved in alcohol.

The eye-caps must be introduced under the eyelids as mentioned in the former chapter, and the eyes well closed. The body is then saturated with a thin coating of turpentine; and after the turpentine is dry, the clothing can be put on, and the body is then ready for interment.

As shown by the preceeding, this process is very simple, and has given satisfactory results in all cases, although the amount of embalming fluid and the composition thereof vary in all cases, according to the temperature of the season and country.

For the minor parts of this process, as for instance the closing of the mouth the reader is referred to previous processes.

EMBALMING PROCESS OF WORTH AND DURAND.

This process, often employed in Europe, has given very satisfactory results, and seems to deserve a good deal of attention. The mode of proceeding differs in some particulars, from the methods already given; also the preparations used in this process are very different from the others, although the principles upon which, it is founded are the same.

The solution employed as an injecting fluid in this case is as follows; *arsenious acid, three ounces; carbonate of soda, four ounces; water, three quarts.*

Dissolve in a porcelain vessel the *arsenious acid* and *soda* in *hot water* and after solution, let the liquor *cool off;* then add enough water to make up *a gallon.* In the making and using of this preparation, a great amount of care should be exercised, as it must be borne in mind, that arsenious acid is a violent poison.

The stomach is then opened as described in former chapters and emptied of its contents: the bowels, also, must be subjected to the same process. The trachea is punctured, and the bronchial tubes completely filled with the solution through the opening thus made. The stomach and intestines should also be injected with the solution, and also the surrounding parts.

The right carotid artery is selected as the point of injection, instead of the left, for the following reasons: The right common carotid artery is shorter than the left; it is also more anterior, and in consequence of proceeding from a branch, instead of from the main trunk, is larger than its fellow.

The common carotid artery in the neck is enclosed in a fibrous sheath, which also contains the internal jugular vein lying to the outer side of the artery, and the pneumogastric nerve, which lies beneath and behind both; the sheath rests on the vertebral column. To the inner side of the carotid is the trachea and larynx; to its outer side, and inclosed in its sheath, the jugular vein. It may be inferred from the above, that the jugular vein in the neck is in close proximity with the carotid artery, and

great care must be exercised in puncturing the artery not to injure the vein lying at its side.

After the injection has proceeded upwards, until the arteries of the head and neck are filled, a very small puncture may be cut into the jugular vein, and the blood allowed to escape at that point until the flow decreases, when the vein may be tied up.

The nozzle of the injector is turned in a downward direction, and the injection continued until a sufficient quantity of the liquid has been injected. The artery is then tied up, and the wound neatly brought together and sewed up.

Some of the same solution may also be poured around the bowels before and after their being replaced in their former position, and the opening in the abdomen is then closed.

SHIPPING EMBALMED BODIES TO DISTANT COUNTRIES.

Instances will at times present themselves where the body of a person is required to be sent to some distant point; at the same time either the family does not feel disposed or able to bear the expense of a metallic casket, or they find it more suitable for their purpose, or congenial to their taste, to procure a wooden or cloth-covered casket. As some lines of railroads will not transport a corpse any distance in anything but a metallic casket, the following may be resorted to:

The body being properly embalmed and placed in the case or casket; this is in turn placed into an outside box lined with sheets of zinc securely soldered together; a zinc lid is sealed by the same means, and the wooden lid of the box screwed down on the top of the whole; thus the casket and body are placed in a semi-metallic envelope practically air-tight.

END PART OF EMBALMING.

Dr. Wywodzoff, of St. Petersburg, Russia, says: For temporary preservation of bodies, the following requisites are necessary: The body should remain in a soft and flexible condition for at least three months, the tissues shall not change color, the mate-

rial should not be injurious to the health of the operator, nor spoil the instruments used in the operation, and it must be either free from or have an agreeable odor, and be cheap, to fulfill the above conditions. The following is recommended by him: Thymolis, 2 scruples; glycerine, 4 pounds; distilled water, 2 pounds. This is used in the form of an arterial injection, and therefore does not present any difference to the general mode of application.

Mr. Laujorry lately presented a note to the French Academy of Sciences, on the antiseptic properties of bichromate of potash. Experiments had shown him conclusively that it retarded indefinitely the putrefaction of bodies. His illustration of the process was as follows:. The body was deprived, as nearly as possible, of all the blood it contained; then the arterial system was filled with about *seven liters* of an *aqueous solution* of *bichromate of potash*, in the proportion of one to a hundred parts of water.. The body was then immersed in a solution of the same substance, but different in specific proportions, *i. e.*, *one part* of bichromate of potash in two hundred parts of water. After three months immersion, the flesh of the body was hardened and almost dry.

The process of Dr. Carra, of Florence, Italy, is as follows: The venous system was emptied, and the arterial circulation filled with a solution of: *Chloride of alumina, 6 pounds; corrosive sublimate, 3 ounces; distilled water, 6 liters.* The body was then immersed in the same solution for sixty days; and at the end of that period of time presented the phenomena of petrifaction.

It is said that the corpse of the great Italian republican, Mazzini, was petrified. Recent travellers say that it proved entirely successful, and that the features of the eminent agitator presented no visible alteration, and the expression well preserved, as he reposes in his tomb, which is opened to the inspection of visitors.

In this last instance, there exists but little doubt that the result thus obtained was due to the employ of those silicates and salts of alumina which are always present in abundance in the soil where these formations are most commonly found.

MODIFICATIONS IN THE MODE OF EMBALMING BODIES.

There are modifications in the processes used for the preservation of bodies, which are governed by circumstances effecting the

different conditions of the body at the time of death. It would require the scope of a cyclopedia to give in detail the proportions of each constituent in the number of different cases, which may come under the notice of the embalmer.

The mode of operation in all cases may be the same, but the nature and quantity of the injection will vary, *first*, with the climatic circumstances of the atmosphere; *second*, with the cause of death; *third*, with the age of the deceased; *fourth*, with the state of the body after death; *fifth*, with the length of time which has elapsed since death took place.

It has been demonstrated in a previous chapter that a high temperature is conducive to rapid decomposition of organic matter; also, that a warm, moist atmosphere will operate in the same manner. It is, therefore, incumbent upon the operator to guard against these two agents of putrefaction, by keeping the body in a moderately cool and well-ventilated place, until the work of preserving is accomplished; also, to give the antiseptics employed, time to successfully destroy and render harmless the dangerous effects of the heat.

It must not be understood by the preceding caution that a body cannot be embalmed in an ordinary room during the heat of summer, but the suggestion herein given is solely for the purpose of facilitating the operation and rendering the success certain; besides, as it has been illustrated in some of the processes precedingly given, the strength as well as the quantity of the injection has been increased when used during the warm season.

As to the modifications to be observed in the treatment of bodies when the cause of death is taken into consideration; it has formed the subject of some chapters to show that, in cases where death is the result of a certain class of diseases, the body is more prone to putrefy than in others; whilst in other cases again the body is, to a certain extent, preserved from corruption by the agents which have proved fatal to the organism; as, for instance, when death has been the result of poisoning, either by *alcohol* or *arsenic*.

The age of the person deceased and the condition of the body after death as also the length of time elapsed since death took place, as effecting the mode of treatment, have all been discussed in a former part of this work, and it is not necessary to repeat the same over again.

The important point which we have to press on your mind is that circumstances in this case are to be strictly investigated; also, that a uniform treatment of all cases, however different the circumstances and conditions, will be a failure; and that a thorough knowledge and experience are necessary to achieve satisfactory results.

Discrimination and judgment are to be used in every case. Some are too ready to condemn a certain process, or to question the properties of some antiseptics, because the first trial of either has proved an ignominious failure; whereas the real cause of all the trouble lies in their ignorance of the laws which govern the mode of proceeding, and the use of the chemicals placed at their disposition.

Others, again, are prone to extol the merits of some preparation, the component parts of which they do not know, but it may have done them good service in several instances; and when, contrary to their expectations, it fails to answer the purpose, they lose faith in it, discard it altogether as worthless, and never entertain the idea that an alteration in the quantity used, or in the combination and strength of constituents, is the real source of mischief. Hence, it is a fact not to be denied that a diagnosis is necessary before the work of embalming be entered into. And he who would endeavor to preserve the body of a stout, fleshy person by the same means employed in the preserving of a body emaciated by long suffering, and under different conditions of temperature, might not meet with a success equal to his expectations.

REVIEW OF THE LESSONS ON EMBALMING.

BY PROF. W. W. BALL.

When full of gases, and the flesh puffed, the face blackened and other-wise distorted, I make an incision and insert a small tube into the artery and also the veins of each arm. In this the pressure of the gases usually starts the blood. When this does not, I connect my pump to assist, by occasionally injecting some suitable fluid. If the face remains black, I make an incision at both arms in the (cephalic) vein to remedy the condition of the face. In most cases of ordinary character, it will conduct the

inky fluids out of the veins of the face and head if taken in time, before the clot of the blood closes it up. In the same manner I operate at each leg, and if the fluids work off readily I await them, and next disperse the gases from the stomach and other cavities of the abdomen; also the thorax (chest); and the lungs, by using a sharp pointed tube which answers for the purpose. But a very much better way is to have several trocar points or tubes, and insert them in all the cavities, and after the gases are all worked out, inject each cavity, taking care not to make the fluids again depress any vessel.

After injecting the vessels and cavities full, give a little time for the flesh to absorb the fluid and you can thus reach all the more remote parts of the system by absorption, as long as the flesh is in proper condition and not full of gas, or too rigid, because sometimes the rigidity will interfere for a time, but this will give away soon, when a good solution is used, as it will soften the tissues somewhat.

Sudden changes of the atmosphere, as an approaching thunder-shower; will frequently produce a condition which creates a spontaneous outburst of decomposition. The atmosphere in this change is loaded with the scavenger of the earth (oxygen) which unites with the decomposing tissues, and thus generates (bacteria germs.) By the use of ice we freeze the water and juices of the flesh, and this only retards putrefaction. By absorbing the water in the flesh with chemicals, we form a dense coagulation of the albumenoids and take up the juices of the flesh by chemical affinities.

Dry air evaporates those fluids .from the surface of the body and thus it retards the process of decomposition by taking the moisture from the tissues, and the oxygen of the air cannot take action as readily when dry, as when moist and damp. If the air is dry and cold, it is much better. When the atmosphere is warm and damp, it induces the fermentive process at once, and thus the fluids sour, while the pores of the skin dampen and form mold spots, by the air's oxygen. With this, microscopical germs and thread-like corpuscles, or bacteria, take hold and soon become innumerable and active agents of speedy dissolution.

The substances of the body that soon become uncontrollable, are: The blood, which remains mostly in the flesh, and in the veins, and seldom or ever in the arteries, although there is

usually some fibrine, while the oily or transparent fluid (serum) is taken up by the flesh from the arteries by the capillary attraction it has for those fluids. (The latter action on the capillaries has long been discredited, but none the less we are ready to defend this assertion with substantial evidence.)

Chemical reagents should readily permeate the tissues from external and internal application, without forming too dense a coagulation of the albuminoids. The fluid (used for embalming) must have very powerful affinity for watery fluids, to dry the tissues and neutralize the gases, and thus render those fermentive fluids inactive, and destroy putrid effluvium and bad odors.

Connected with the alimentary canal, are several large glands, a few of which have already been described. They are soft solids of various forms and sizes, and are composed of lobules or small divisions, each one of which is supplied with an artery, vein and duct. Each of these ducts communicates with the principal duct or outlet, which conveys away the product separated from the blood by the gland. In microscopic structure a gland is made up of very minute cells, which seem to have the power of secreting or separating from the blood the particular substance which it is the function of the gland to eliminate.

The peritonoeum covering or external coat of the intestines, is not a little peculiar in its conformation. This, like all serous membranes, first completely invests the organs, and then is reflected from them so as to make a lining for the whole cavity. Hence the cavity of the abdomen, although a perfectly shut sac, may be seen from the fact, that in dropsy of the abdomen, the fluid has no means of escape except by absorption or puncture from the outside. In the disease commonly known as inflammation of the bowels, this membrane is the principal seat of the difficulty, and the inflammation of this, as well as all other serous membranes is attended with acute pain and the progress of the disease for better or worse very rapid. The *mesentery* (meaning the middle of the abdomen) is a fold of serous membrane which hangs over the greater portion of the intestines, and is thickly inlaid with fat, even in persons of moderate size. The point of attachment on the front side of the body is along the course of the transverse colon, hanging like a short apron from the lowest portion of the waist. After being reflected upon itself, it is attached to the posterior walls of the abdomen, near the

spinal column. Small bodies called *mesenteric glands* are also found in the fold, which has an important connection with the Lacteals; they belong to the class of Lymphatics. The main use of the mesentery is to form a cushion of fat in order to protect the included organs from cold and violence, as well as to give them a yielding surface to glide upon during their tortuous movements.

The *Lacteals* are minute vessels which commence with the inner or *mucous coat* of the intestines, and terminate in the *thoracic duct.* Soon after they leave the intestines, several of them unite into one, and pass through small bodies of about the size of peas, called the *mesenteric glands.* As they emerge from these glands, they are fewer in number but larger in size, until they all unite into one tube called the *thoracic duct*—a little larger than a goose quill—at about the point of the last dorsal vertebra. The *lacteals* and the *thoracic duct* are all made up of three coats, and presents a *silvery-white appearance* from the color of the fluid they contain. Their function is to convey the chyle or nutrient portion of the food into the blood.

With persons in good health, there is a larger abundance of this *fatty tissue* and *lymphatic fluids*, which, with the fluids of the blood vessels and the juices of the flesh, constitute the fluid constituents, and become the fuel for the fire of dissolution after the vitality is extinct. Another agent of putrefaction is the *gastric fluid.* In life, as soon as the food reaches the stomach, the most important part of the process of digestion commences. Whenever any solid substance comes in contact with the inner or mucous membrane of the stomach, it excites the *gastric glands* to pour out in abundant quantity the gastric fluid. This fluid is a transparent liquid of a little greater consistency than water, and of a perceptibly acid taste. It possesses the property of coagulating albumen and of separating the whey or serum from the milk in a very short time, and is secreted at the rate of *seventy ounces* per day. This property, however, is owing to a peculiar organic compound called *pepsin*, which acts after the manner of a ferment at the normal temperature of the human body. The gastric fluid also possesses antiseptic properties, or the power of preventing decay or putrefaction for a long time. These three properties—the acids, fermentive and antiseptic—are of service in the following manner: The *acid* assists in the solution of the dif-

ferent materials in the stomach. The *pepsin*, which constitutes two-thirds of the solid materials of the gastric juice, does its office by establishing the lactic fermentation, such as is seen in the changes through which milk passes in hot weather. The *antiseptic* properties are important in order to prevent putrefaction, which would be so liable to be set up among organic substances in such a condition, and at such an elevated temperature as the stomach usually possesses.

In this way, we might continue to define other substances of organic life within the human organism, which in health gives vigor and life, and in death are found to baffle the masters of our art. When the public have been educated to commit their dead to competent hands, in a manner that is necessary for their preservation, then it will soon be proven by our profession that it is no longer necessary to search Egyptian catacombs for what is termed as the lost art, notwithstanding the unfavorable condition of the elements in nature, which have to be combatted or overcome by a remedy to ward off the scavenger oxygen.

FINIS.

TREATISE

—— ON ——

EMBALMING

INCLUDING

A FULL AND CONCISE DESCRIPTION OF THE METHODS TO BE EMPLOYED FOR THE PRESERVATION OF THE HUMAN BODY AFTER DEATH, BY CHEMICAL OR OTHER KNOWN PROCESSES;

TOGETHER WITH A FULL DESCRIPTION OF CHEMICALS EMPLOYED IN EUROPE AND THE UNITED STATES, BY THE MOST EMINENT CHEMISTS AND PROFESSORS; ALSO, SUCH ANATOMICAL, PHYSIOLOGICAL AND CHEMICAL FACTS, AS ARE NECESSARY TO BE UNDERSTOOD, IN ORDER THAT SCIENTIFIC MANIPULATIONS MAY BE FULLY CARRIED OUT.

BY

M. LESSLEY.

TOLEDO, OHIO:
1884.

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